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THESIS

AN ANALYSIS OF THE
COST OF BASE REALIGNMENT ACTIONS (COBRA)
MODEL

by

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December, 1993

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As the result of the deliberations of the 1993 Base Realignment and Closure Commission, the Department of Defense will close or realign over 100 military installations at a cost of over $5.5 billion. The Cost of Base Realignment Actions (COBRA) model is the primary financial analysis tool used by the Base Realignment and Closure Commission and the military departments to evaluate the costs and benefits of proposed base closures and realignments. This thesis examines three critical aspects of the model: the estimation of military construction costs, the prediction of overhead savings, and the choice of discount rate. COBRA cost estimates are compared to actual military construction costs for three Navy bases selected for closure/realignment in 1988: Naval Station, Brooklyn; Naval Station, Sand Point; and Naval Station, Hunters Point. Cost estimating relationships for overhead costs are developed for five categories of Navy/Marine Corps installations and compared to the COBRA models for overhead costs. The discount rate used for COBRA net present value analyses is evaluated with respect to directives in Office of Management and Budget Circular A-94. The final chapter draws conclusions on the accuracy of the COBRA model, identifies changes that may be made to improve the model, and suggests ares that require additional research.

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An Analysis of the
Cost of Base Realignment Actions (COBRA)
Model

by

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ABSTRACT

As the result of the deliberations of the 1993 Base Realignment and Closure Commission, the Department of Defense will close or realign over 100 military installations, at a cost of over $5.5 billion. The Cost of Base Realignment Actions (COBRA) model is the primary financial analysis tool used by the Base Realignment and Closure Commission and the military departments to evaluate the costs and benefits of proposed base closures and realignments. This thesis examines three critical aspects of the model: the estimation of military construction costs, the prediction of overhead savings, and the choice of discount rate. COBRA cost estimates are compared to actual military construction costs for three Navy bases selected for closure/realignment in 1988: Naval Station, Brooklyn; Naval Station, Sand Point; and Naval Station, Hunters Point. Cost estimating relationships for overhead costs are developed for five categories of Navy/Marine Corps installations and compared to the COBRA models for overhead costs. The discount rate used for COBRA net present value analyses is evaluated with respect to directives in Office of Management and Budget Circular A-94. The final chapter draws conclusions on the accuracy of the COBRA model, identifies changes that may be made to improve the model, and suggests areas that require additional research.

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I. INTRODUCTION

A. BACKGROUND

The breakup of the Soviet Union and the chronic increase in federal budget deficits have signalled a new era of lean defense budgets. The U.S. military no longer faces the primary threat that had defined its force structure and justified its spending for the previous forty years. After two decades of increasing annual budget deficits, the people and government of the United States are eager to trim the defense budget and shift the commitment of national resources from national security purposes to other uses. For these reasons, U.S. defense spending (as a percentage of gross domestic product) in 1993 will dip to its lowest level since the demobilization after World War II [Ref. 1].

As defense budgets become leaner and the U.S. military downsizes to post Cold War force levels, the military base structure must also be reduced. Reducing the base structure to remove excess capacity allows the Department of Defense to avoid the costs of operating excess bases, costs which can be substantial. The President's Private Sector Survey on Cost Control (commonly known as the Grace Commission) concluded in 1983 that even a ten percent reduction in the existing base

structure could save the Department of Defense $2 billion per year in operating costs. [Ref. 2]

Reducing the military base structure also reduces the opportunity cost to the American public of operating military bases. According to Professor Fred Thompson, who has given expert testimony before the Armed Services Committees, these opportunity costs, the "...sacrifice of any better or higher uses to which these millions of acres of real estate could be put..." [Ref. 3] are unquestionably large. He states:

> If, for example, we could allocate the two million of these acres with the highest market values to their best alternative economic uses without harming the national defense, we could reduce the opportunity cost of maintaining the existing base structure by at least $35 billion and perhaps by as much as $90 billion. [Ref. 4]

Unfortunately, even though federal officials agree that large savings can be achieved by reducing the military base structure, making decisions to close excess bases has been difficult. Most research points out that the primary reason for this is the parochial interests of the members of Congress. According to Douglas Arnold, congressmen must "...protect the military installations in their districts, because local beneficiaries see such installations as semi-permanent benefits ... adverse decisions may suggest incompetence or lack of interest in their constituents." [Ref. 5] Legislators were indeed effective at keeping

the installations in their districts from closing; from 1977[1] until the first Commission on Base Realignment and Closure in 1988, not a single major base was closed. [Ref. 6]

Realizing that conventional legislative procedures were ineffective for base closure decisions, the Department of Defense established the Commission on Base Realignment and Closure (BRAC) on May 3, 1988. Congress gave the Commission its official power later that year when it passed Public Law 100-526, the Defense Authorization Amendments and Base Closure and Realignment Act. This law required the President and Congress to accept all or none of the Commission's realignment and closure recommendations. [Ref. 7]

Since its formation in 1988, the Base Realignment and Closure (BRAC) Commission has been asked to make difficult decisions on the closure and realignment of military bases. From the beginning, the charter of this Commission has been to evaluate the military base closures proposed by the Secretary of Defense and the military departments, and to select the best candidates for closure based on specific criteria. Evaluation of the estimated cost savings of each proposed closure is a vital part of the process, since the overall objective of base closure and realignment is to eliminate

[1] In 1977 Congress passed legislation that gave the Armed Services Committees the power to review all military base closure decisions, thus giving Congress the power to make all base closure decisions.

excess capacity and avoid future costs. The potential cost savings are substantial: the 1988 BRAC estimated the 20-year net present value of the savings from the first round of base closures at $5.6 billion in 1988 dollars. [Ref. 8]

To evaluate the potential costs and savings of the base closure alternatives under consideration, the BRAC has developed a cost estimating model that attempts to capture all essential costs and savings associated with each alternative. This model, the Cost of Base Realignment Actions (COBRA) model, was developed by the U. S. Air Force Cost Center in conjunction with the Logistics Management Institute. The model was used to produce all of the cost estimates for the 1988 Commission, which were reviewed by the Government Accounting Office (GAO) for accuracy. The model was then revised to accommodate some of GAO's concerns and adapted for use by each of the military departments.

The COBRA model is designed to estimate the costs and savings associated with a proposed base closure or realignment, using data that are available to the military department staffs without extensive field studies. Thus these data can be used to compare the relative cost differences between various base closure alternatives.

COBRA has been used by the military departments and the BRAC to produce the cost estimates for the 1991 and 1993 base closures and realignments. However, intense congressional scrutiny of the actual costs of closing bases and savings

achieved has raised questions as to its use as a decision tool. [Ref. 9] Economists have questioned whether significant costs such as environmental cleanup costs and unemployment benefits should be included in the COBRA model. Perhaps more significantly, the Government Accounting Office continues to report substantial differences between the actual savings due to base closures and the savings predicted using the COBRA model. [Ref. 10]

This thesis attempts to address these issues by comparing the initial COBRA estimates with the actual costs and savings data for Navy bases that have completed a major portion of the closure process. The study empirically validates the costs/savings estimates and points out discrepancies that may be used to improve the model and its use as a decision-making tool.

B. OBJECTIVE

The purpose of this thesis is to evaluate the COBRA model as an economic decision-making tool. It analyzes the model to determine if it captures all significant costs of base closure/ ˎalignment and if its economic assumptions are valid. In addition, the actual cost and savings data for the Navy installations which have already begun the closure process are compared with initial COBRA estimates.

C. RESEARCH QUESTIONS

The primary research question is: Is the Cost of Base Realignment Actions model a valid financial decision-making tool?

Subsidiary research questions include the following:

- What is the COBRA model and how does it function?
- Is the COBRA model based on sound cost estimating principles?
- What are the economic assumptions made by COBRA?
- How well do these economic assumptions match actual economic parameters and would change of these parameters over the relevant range affect the rank ordering of the base closure alternatives?
- Are the cost estimates produced using the COBRA model useful for predicting the actual costs/savings incurred for bases that are being closed or realigned?
- If the cost estimates produced using COBRA are not accurate, is this discrepancy caused by deficiencies in the model or problems with the economic assumptions and data input?
- What changes can be made to improve the accuracy of the COBRA model and enhance its value as a decision-making tool?

D. SCOPE

The main thrust of this study is to evaluate the COBRA model as an economic decision-making tool. This is accomplished by first examining the cost estimation literature and comparing the methods used by COBRA with those derived from the literature. Special attention is given to previous analyses of the model by the Government Accounting Office

(GAO) and the changes made to the model during its evolution to the current form.

After assessing the model analytically, this study compares the actual costs and savings data with the initial COBRA estimates for the Navy installations which have already completed most of the closure process. The sample size is limited to those Navy bases designated for closure by the BRAC in 1988 and 1991 for which a significant portion of the closure costs and savings are known. The bases examined were: 1) Naval Station, Brooklyn, 2) Naval Station, Sand Point, Washington, and 3) Naval Station, Hunters Point, California.

E. METHODOLOGY

The research was conducted in the deductive mode with the intent of rejecting/not rejecting the following *a priori* hypothesis:

> The COBRA model produces cost estimates that lead to sound financial decisions.

Analytical, expert opinion survey, and archival research methods were used.

A comprehensive search of the literature of cost estimation and capital budgeting preceded the analysis of the COBRA model. Previous analyses of the model were reviewed; special attention was given to previous analyses of the model performed by GAO and to changes made to the model as a result of GAO recommendations. Expert opinion data were gathered

through interviews with the members of the Navy's Base Structure Analysis Team and the analysts responsible for the review of the budget performance for installations undergoing the base closure process.

Finally, archival data were examined from the budget performance documents of the sample Navy bases undergoing closure and compared to the initial estimates produced using COBRA.

F. ORGANIZATION OF THE STUDY

This thesis is divided into six chapters, beginning with this introduction. Chapter II describes the factors considered when closing a military base and preparing it for disposal. These include the costs of preparing the bases that will receive personnel and missions from the closing base as well as the costs to relocate personnel and equipment. Chapter III describes the cost-benefit analysis approach and calculational methods of the COBRA cost model. Chapter IV surveys the previous studies on the COBRA model and summarizes the modifications made to the model during the period 1989-1993. Chapter V analyzes the model in light of these studies and compares actual cost/savings data with the original COBRA estimates for the sample Navy bases. Chapter VI summarizes the findings and draws conclusions on the usefulness and accuracy of the COBRA model.

II. BASE CLOSURE COSTS AND SAVINGS

A. INTRODUCTION

This chapter provides a framework for identifying all of the costs and savings associated with base closures. It categorizes the costs and savings to DOD and the federal government using the Congressional Budget Office guidelines for analysis of base closure costs in Department of Defense Reports [Ref. 11].

The chapter is divided into ten sections, including this Introduction. Section B provides an overview of the magnitude of the costs and savings due to closing bases. It introduces the concepts of one-time and recurring costs/savings. Sections C through J provide descriptions of the specific categories of costs and savings using the CBO guidelines mentioned above. The final section (K) summarizes the chapter.

B. OVERVIEW

"It takes money to make money," and "there is no such thing as a free lunch," are frequently quoted business adages. Although they perhaps oversimplify, these phrases capture succinctly the fundamental concept of closing military bases. A relatively large one-time investment is required to close a base before future savings can be achieved. The BRAC

Commission estimated the total one-time implementation costs for the 1988 round of base closures at $3.1 billion [Ref. 12].

Lest these huge one-time costs deter the Department of Defense from closing bases, Congress established the Base Closure Account to provide the initial investment. The Base Closure Account provides funds for military construction, relocation expenses, environmental cleanup costs and other one-time costs that are incurred as a result of base closure. The decision to appropriate funds specifically for base closures appears prudent, since the military departments were reluctant to use funds from already lean Operations and Maintenance and Military Construction Appropriations to pay the costs of closing bases. Providing separate funds earmarked for base closure forced financial decisions and sped up the process so that savings could be achieved sooner.

Although the DOD incurs many different types of costs when it closes bases, a small number of these types account for the vast majority of the total dollar amount. Military construction and environmental cleanup costs are the two largest one-time base closure costs, accounting for over two-thirds of the total. Figure 1 illustrates the relative magnitudes of these costs.[2] The Operations category of Figure 1 includes several types of costs: severance pay and

[2] Figure 1 was created using data from the 1993 DOD Budget justification for BRAC-I (the 1988 round of closures).

early retirement pays for civilian employees, relocation costs, etc.

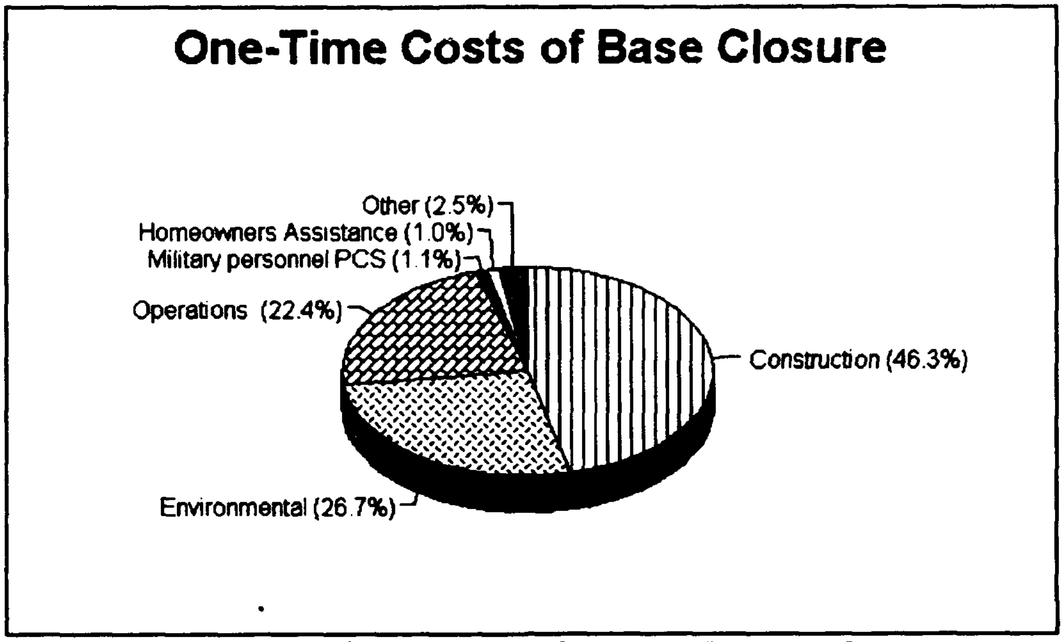

Figure 1 One-Time Costs of Base Closure for BRAC-I

The sizable future savings that can be achieved by closing bases justifies these substantial one time costs: The GAO conservatively estimates that the 1988 base closures will save the Defense Department $453 million annually. [Ref. 13] These recurring savings occur because the number of civilian and military positions (and thus payroll costs) and non-payroll overhead costs (such as utilities and maintenance) are reduced.

As is the case with one-time costs, a few categories account for the vast majority of the total dollar amount of the recurring savings. Figure 2 illustrates the relative magnitudes of the recurring savings from BRAC-II (the 1991

round of closures). Military and civilian payroll savings and overhead savings account for over 95 percent of the recurring savings.[3]

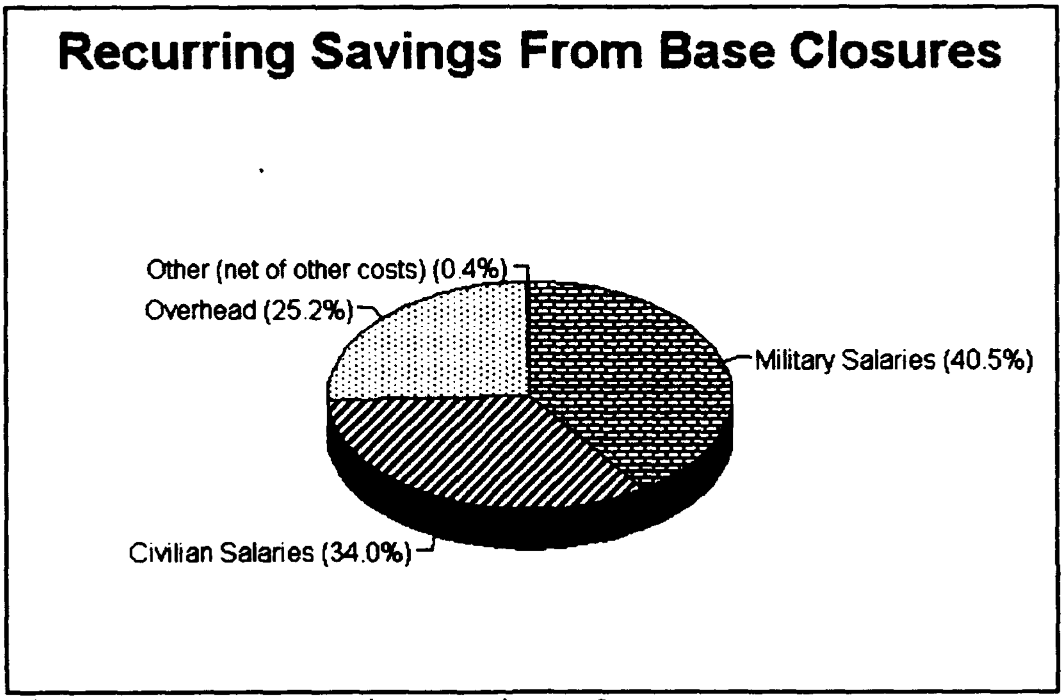

Figure 2 Recurring Savings from BRAC-II.

Not all of the savings from base closures recur annually; some are "one-time" savings. "One-time" savings occur whenever one time costs that would occur if a base remained open are avoided; for example, cancelling a programmed military construction project at a closing base saves MILCON funds. Throughout this chapter savings are considered true savings if they represent dollars eliminated from the DOD Future Years Defense Plan (FYDP).

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[3] The source of the data for Figure 2 was the 1993 DOD Budget justification for BRAC-II.

C. MILITARY CONSTRUCTION COSTS AND SAVINGS

Military construction costs comprise a large share of the one time costs associated with base closures, accounting for over $1.5 billion for the 1988 round of base closures [Ref. 14]. Military construction may be required when closing a base because before a base can be closed, its personnel, equipment, and other mission essentials must be transferred to a receiving base where the mission will be continued. If the receiving base does not have excess building capacity in suitable condition to support the personnel and equipment, then a military construction project is funded. If excess capacity exists, but in unsuitable condition, then military construction funds are used to rehabilitate the facility. The funds spent for new construction or rehabilitation are considered a cost of base closure because they would not be spent if the base were not closed.

Alternatively, closing a base may result in saving military construction funds. When a base is chosen for closure, the military construction projects programmed for the base may no longer be needed and thus may be cancelled. The funds that are not spent, net of any excess cost to terminate contracts, represent savings to the Department of Defense. These savings are attributed to the base closure action because the funds would be spent if the base remained operational.

D. REAL ESTATE COSTS AND REVENUES

Once a military base is closed and the land has been restored to proper environmental standards, the real property may be sold or leased to generate revenue. This revenue (net of the costs to promote the sale) is applied to the Base Closure Account and thus represents a one-time savings to the Department of Defense. Early estimates of the land sales proceeds for the twelve largest of the bases chosen for closure in 1988 ranged from $1.0 to $1.35 billion [Ref. 15].

Unfortunately, the large number of regulations governing disposal of federal property and the continued slow pace of environmental cleanup have made the proceeds from land sales very uncertain. The Navy has yet to realize any land sales revenue from base closures, and estimates for the total DOD proceeds from land sales from 1988 base closures have been revised downward from $2.3 to $1.1 billion [Ref. 16].

The Department of Defense has had to purchase land to support some base closures. In these cases the receiving bases did not have adequate land to support the personnel, equipment and mission transferred from the closing base. These purchases are a cost attributed to the base closure process because they would not occur if the base were not closed. These costs can be defined with much greater certainty than the savings from land sales.

E. PERSONNEL COSTS AND SAVINGS

The lion's share of the recurring savings from base closures comes from the elimination of military and civilian positions. This is to be expected, since civilian labor costs account for approximately 60 percent of the total cost of operating a military base. In fact, for the 1988 round of closures, personnel reductions account for 84 percent of the $381 million in recurring savings to the Air Force [Ref. 17]. Accurate prediction of the savings due to personnel reductions is essential when estimating the total savings a base closure will achieve.

When the DOD closes or realigns military bases, it eliminates some or all of the civilian and military positions at the affected bases. The disposition of the affected employees determines the amount of personnel costs and savings due to the closure action. The DOD may transfer civilians and military members to a receiving base where the number of positions is increased. In this case no savings are achieved because the number of employees and therefore payroll costs have not decreased.

Alternatively, the DOD may choose not to transfer civilian employees to new or previously existing positions, removing them from the federal payroll using a Reduction in Force (RIF). It may place the affected civilian employees in another federal job as part of the Priority Placement System. Some of the affected civilian employees may choose early

retirement or resign from their positions. In these cases, savings can be achieved if no new employees are hired to take their places, in other words, if the positions are eliminated. The savings are attributed to the base closure only if the positions are eliminated directly by the closure action and not by some other mandated reduction in the civilian work force.

In a like manner, the DOD may produce recurring savings by reducing the number of military positions when it closes or realigns bases. Again, the savings are attributed to base closure only if the military positions are eliminated by the base closure action. Savings that accrue when military positions are eliminated to meet goals for planned military force reductions, even if concurrent with base closings, do not count as base closure savings.

Closing bases involves personnel-related costs as well as savings. The Department of Defense does not enjoy a "free lunch" when it eliminates civilian or military positions. If the civilian employees or military members affected by base closing choose early retirement, then the DOD must consider the marginal cost of providing early retirement benefits as a base closure cost. If DOD uses a Reduction in Force to eliminate civilian positions, then the severance pay it gives to fired employees is a base closure cost. The DOD may also be required to reimburse state governments for the cost of

unemployment compensation paid to workers who lose their jobs when a base closes.

F. BASE OPERATIONS AND SUPPORT COSTS AND SAVINGS

The base closure process generates other substantial recurring savings by reducing the total overhead costs to operate the military base structure. Military base operations are supported by two separate funds, one for the maintenance costs of real property and the other for non-payroll costs of base operating support. When the DOD closes a base, it sheds the costs to maintain the buildings and grounds and to provide services to base personnel and tenant commands.

Alternatively, the bases that receive the mission and personnel from the closing base will see their overhead costs rise. Net savings will occur if the base support funds saved at the closing base are greater than the increase in costs at the receiving bases. This is usually the case when the receiving base has excess capacity and economies of scale can be achieved.

The Department of Defense incurs other costs if the base is deactivated[4] (instead of closed) or if the closing process is protracted. In either of these cases, DOD pays caretakers

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[4] When a base is deactivated, the activities are transferred to other bases and a caretaker force is left in place to provide minimal maintenance and security. The lands are not disposed of and the base can be reactivated if needed.

to provide minimal maintenance for the grounds and buildings until the properties are sold or reactivated.

G. RELOCATION COSTS

Relocation costs are a relatively smaller portion of the one time costs of closing a base, but they are not insignificant. Before a base can be closed, the equipment (aircraft, vehicles, and tools) and personnel must be transferred to receiving bases where the activities will be continued. The DOD pays for the packing, unpacking, freight, and setup of transferred equipment. It incurs additional costs when transferring specialized equipment; for example, sophisticated laboratory equipment may require special handling and require expensive recalibration after transfer.

Relocating civilian and military personnel involves different types of costs. The DOD pays the total permanent change of station (PCS) costs for all civilian and military personnel transferred during the closing process. However, since military members receive PCS orders at regular intervals regardless of base closings, the cost of the PCS moves that would have normally occurred during the closure period should be excluded from base closure costs.

The DOD may be responsible for other costs of transferring civilian employees. The Housing Assistance Program provides payments to transferring federal employees who stand to lose significant sums upon sale of their homes because of depressed

housing prices. These payments are a cost of base closure because they would not be made if the affected military base remained operational.

H. ENVIRONMENTAL CLEANUP COSTS

The cost of environmental cleanup at closing bases continues to skyrocket. The military department estimates of the cleanup costs for the bases chosen in 1988 have climbed from $510 to $859 million [Ref. 18]. Experience with the 1988 closures shows that cost estimates increase significantly (sometimes by a factor of ten) after the detailed studies and ground tests are complete. Pease Air Force Base is representative of this trend:

> ... the preliminary environmental cleanup estimate was $11 million. In fiscal year 1992, the Air Force increased the estimated cleanup to over $63 million and to over $102 million in fiscal year 1993 when it had the benefit of studies and tests that were not previously available. By December 1992, the estimate had increased to over $114 million [Ref. 19].

If the trend continues, the cleanup costs for the 1991 and 1993 rounds, currently estimated at $2.7 billion, will become monumental.

Since 1991 the Base Closure Account has provided the funds for environmental restoration of closing bases; however, the DOD and reviewing agencies have not considered these restoration costs as "base closure costs" per se. The current policy of the DOD is that environmental cleanup costs should not be a factor in the base closure decision process; it

excludes these costs from its net present value analyses. The DOD believes environmental restoration costs are sunk costs since public law requires DOD to clean up the bases whether or not they are closed[5].

Although DOD is required to clean up bases regardless of closure decisions, the enormous costs of cleanup may in the short term "squeeze out" defense spending in other areas. GAO predicts that environmental cleanup costs will have "significant budgetary impact since pressure for rapid conversion and reutilization of closed bases will not allow these costs to be spread over many years." [Ref. 20] The opportunities that DOD forgoes to redirect its funds to accelerate environmental cleanup have some value or cost that should be recognized as part of base closure decision. This issue is addressed in more detail in Chapters IV and V.

I. HEALTH COSTS

When DOD closes medical facilities at a base, the retirees and dependents who previously used these facilities and remain in the area must use civilian health care facilities. This increases the costs to the Civilian Health and Medical Plan of the Uniformed Services (CHAMPUS) and to Medicare. However, if medical facilities are expanded at a receiving base during the

[5]The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Public Law 96-510) and Superfund Amendments and Reauthorization Act of 1986 (Public Law 99-499) require DOD to restore contaminated sites.

closure process, more retirees and dependents in that locale may be able to receive care at DOD facilities. This reduces CHAMPUS and Medicare costs to the federal government, and reduces the net increase in health care costs due to base closings.

J. ECONOMIC GRANTS

The federal government has provided substantial financial assistance to the communities affected by base closures [Ref. 21]. From 1966 through 1987, federal agencies provided $963 million (in 1988 dollars) in assistance to communities affected by base closure or realignment; however, it is hard to estimate the amount of economic aid that will be available in the future. When asked how much funding they could provide to communities affected by the base closures in 1988, agency heads stated that "substantially smaller amounts" of funds were available [Ref. 22]. Although it may be difficult to estimate the amounts of these grants, they are still a cost of base closure.

K. SUMMARY

In summary, closing military bases requires a relatively large one-time investment in order to achieve future savings. Two categories of costs, military construction and environmental cleanup costs, account for the majority of this large initial investment; however, large potential recurring

savings may justify the initial costs. As was the case with the initial or one-time costs, a few categories account for nearly all of the recurring savings. Military and civilian salary savings and non-payroll overhead savings make up over 95 percent of the recurring savings. Thus the accurate estimation of these few categories of costs and savings is crucial if the DOD is to make sound financial decisions as it closes bases. The methods that the COBRA model uses to estimate these costs and savings are the subject of the next chapter.

III. COST OF BASE REALIGNMENT ACTIONS MODEL

A. INTRODUCTION

This chapter describes the cost-benefit analysis approach and calculation methods of the Cost of Base Realignment Actions (COBRA) model. The chapter is divided into five sections, including this Introduction. The second section gives a brief history of the development and subsequent modification of the COBRA model for use during the 1993 round of base closures. The third section describes the cost-benefit analysis methods used by the COBRA Model. It includes a brief explanation of the net present value techniques of the model and a definition of its key outputs. The fourth section describes the COBRA algorithms for calculating the costs and savings due to base closure actions. The final section summarizes the chapter's findings.

B. DEVELOPMENT OF THE MODEL

The original Cost of Base Realignment Actions (COBRA) model was developed by the Air Force Cost Center, in conjunction with the Logistics Management Institute (LMI), to evaluate the costs of Air Force stationing actions. Realizing the basic model had more general applications, the first Base Realignment And Closure Commission adopted the model to evaluate the relative costs of its base closing and

realignment decisions. The Commission revised the model so it could be applied to all the Services, and used it to produce the cost and savings estimates for all of its recommendations.[Ref. 23]

The General Accounting Office (GAO) and the Congressional Budget Office (CBO) reviewed the model subsequent to the 1988 Commission's Report and found the "Cost of Base Realignment Actions model used by the Commission and the services is a conceptually sound tool for evaluating costs, savings, and payback periods."[Ref. 24] However, the GAO also found some errors in the model and provided the DOD with a list of recommended improvements to add to the model prior to the 1991 round of base closures.

The Department of the Army was given responsibility for the modification of COBRA. The Army tasked Richardson and Kirmse (R & K) Engineering to examine the model and provide recommendations for improvement. The most significant of these recommendations was to convert the COBRA model from its original Lotus 1-2-3 spreadsheet format to a true computer model using the PASCAL language. R & K subsequently converted COBRA to PASCAL for the 1991 Commission, and the Secretary of Defense directed the services to use the new standardized model for all future base closure and realignment recommendations.[Ref. 25]

The GAO and CBO examined the model subsequent to the 1991 Commission (as they had after the 1988 Commission) and again

found the model conceptually sound but in need of minor improvements. Prior to the 1993 Commission, representatives from all of the Services and the Office of the Secretary of Defense participated in working groups that addressed the model's weaknesses and proposed several changes. R & K incorporated these changes into the latest version of COBRA (version 4.04) used by the 1993 Commission.[Ref. 26]

C. COST-BENEFIT ANALYSIS

The COBRA model is a cost-benefit analysis tool that allows evaluation of base closure alternatives based on the net present value (NPV) of the proposed scenario. The net present value concept is a widely accepted means of evaluating the worth of alternative programs; industry routinely relies on net present value analysis when making capital budgeting decisions and economists have often used the concept to evaluate government policy alternatives. The Office of Management and Budget (OMB), which sets guidelines for all executive agencies, has declared that net present value shall be "the standard criterion for deciding whether a government program can be justified on economic principles." [Ref. 27]

The chief advantage of the net present value approach is that it recognizes the time value of money when analyzing the costs and benefits of alternative programs. A base closing decision that saves one dollar immediately is preferable to

one that saves one dollar a year later. The dollar saved immediately can be invested and earn a return for a year, accumulating greater value. The dollar saved immediately is thus worth more than the single dollar saved at year's end.

The COBRA model converts all base closure costs and savings into their worth at the present time, allowing valid comparisons between alternatives whose costs and savings may occur at different dates in the future. The COBRA User's Manual describes the process as follows:

> COBRA calculates the costs and savings of base closure/realignment scenarios over a period of 20 years, or longer if necessary. It models all activities (moves, construction, procurement, sales, closures) as taking place during the first six years, and thereafter all costs and savings are treated as steady state. The key output value produced is the Payback Period or Return on Investment Year. This is the point in time where savings generated equal (and *then exceed*) costs incurred. In other words, this is the point when the realignment/closure has paid for itself and net savings start to accrue. [Ref. 28]

Figure 4 illustrates the net discounted savings/costs for a typical base closure scenario with large one-time costs and savings spread out over future years. The closure action is assumed complete (all of the one-time costs and savings have occurred) within the first six years[6]. During this period the sum total of the discounted costs are greater than the discounted savings. However, as steady state savings accrue

[6] Public Law 100-526, the Defense Base Closure and Realignment Act of 1988, prescribed that all closures and realignments recommended by the Commission in 1989 shall be completed by the end of fiscal year 1995.

in the following years, the sum total of the discounted savings exceeds the total discounted costs and payback is achieved. (The figure's y-axis is defined in terms of costs, therefore net savings will have a negative value.)

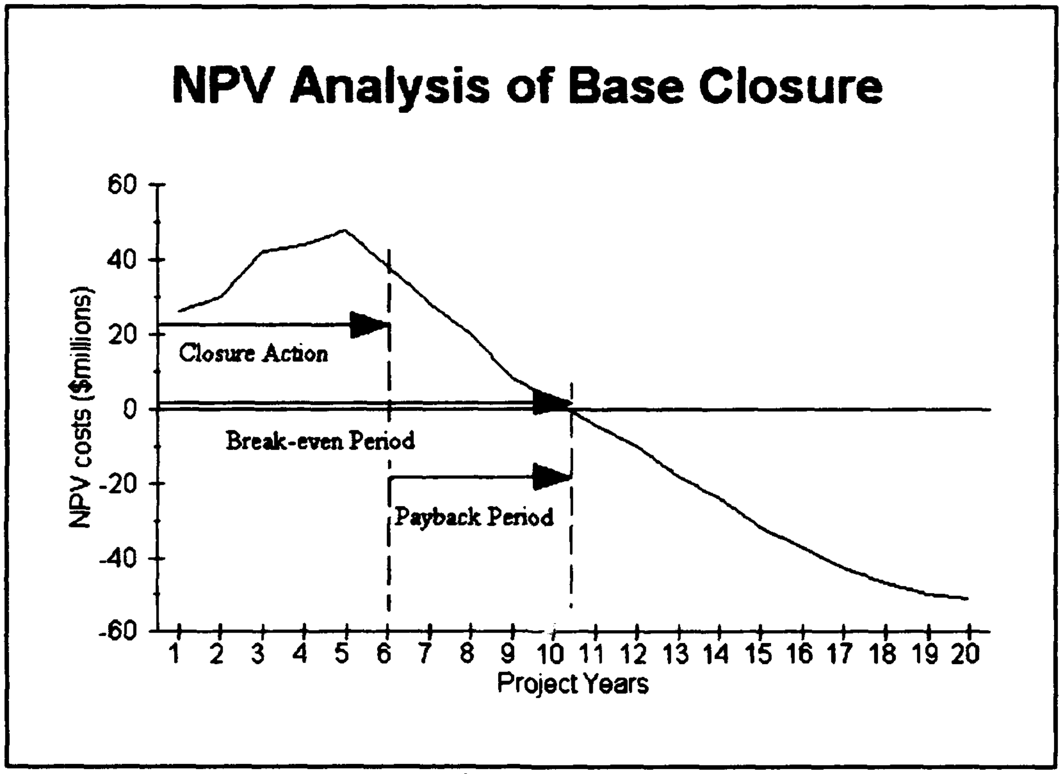

Figure 3 Payback Period for a Typical Base Closure

In addition to the net present value criteria, COBRA compares base closure alternatives in terms of how soon Return on Investment, or Payback, is achieved. For alternatives with similar net present values, the alternative with a shorter payback period might be preferable since the savings are less

dependent on the long-term validity of the discount and inflation rates used in the analysis.

D. CALCULATION METHODS

The COBRA model uses a "standardized" approach to calculate the costs and savings of different base closure scenarios. This approach makes COBRA useful for comparing multiple complex basing scenarios without the need for extensive data collection efforts at each installation. However, this approach also limits the model's applicability; a "standardized" approach can not possibly account for all the possible costs and savings for the entire spectrum of DOD installations. [Ref. 29]

The COBRA standardized calculation methods require three types of data: standard factor, site-specific, and scenario-specific data. Standard factors are service-wide estimates for values common to nearly all installations. They include the average officer salary, average enlisted salary, average cost per square foot for different types of military construction, and average cost per ton-mile for freight. These estimates are obtained from historical data, published pay tables, or cost estimating relationships already in use.

Site-specific data are "snapshots" of a particular installation. They include the number of personnel, square footage of facilities, overhead budget, and housing data. The scenario-specific data are determined by the specific

alternative under consideration. They include the number of personnel relocating or being eliminated, the facilities to be shut down, and the military construction required at the receiving bases. [Ref. 30]

COBRA uses these three types of data to calculate the one-time and recurring costs and savings of each base closure alternative. The one-time costs/savings are to a large degree determined by the scenario-specific data, while the recurring costs/savings are the result of the differences between the closing and gaining bases, such as overhead rates, housing allowance levels, and the number of personnel required at the gaining base. [Ref. 31]

The Logistics Management Institute, in its first report on COBRA, describes the different calculations as follows:

> COBRA makes two types of calculations based on these two categories of costs and savings. One-time costs are computed as standard charges for item-by-item actions; in doing so, the model applies Service-wide standard costs and factors to scenario-specific inputs. Recurring costs and savings are computed by comparing the cost of specific services at the gaining and losing bases and predicting how much it would cost to perform the transferred services at the gaining base. [Ref. 32]

COBRA performs dozens of these calculations for each scenario in an effort to capture every possible significant cost and saving.

Although the model collects many different types of costs and savings, a few categories are responsible for the lion's share of the dollar amounts. Military construction and

environmental cleanup costs dominate the one-time costs of closing bases (see Figure 2 in Chapter II), while overhead and civilian/military salaries savings make up virtually all of the recurring savings (see Figure 3). Thus the accurate calculation of the costs/savings in these categories is crucial to the overall accuracy of the COBRA estimate.

COBRA uses the standard factor approach to estimate military construction costs. During the call for scenario-specific data, an estimate is made of the type and size (in square feet) of buildings and facilities that will need to be constructed at gaining bases. COBRA then estimates the cost of the proposed facilities using standard cost factors for the type of facility and regional cost factors that account for construction price differences between regions. The model allows this estimate to be overridden if a detailed engineering cost estimate for the proposed construction already exists.

The model also uses standard factors to calculate civilian and military salaries savings. The site-specific data for the closing base includes the current number of civilian positions. COBRA uses standard factors for the normal turnover rate and early retirements to calculate the number of employees that will remain at the closing base. The model then calculates the number of these remaining positions that will be eliminated using a "RIF" factor, a standard factor that describes the percentage of the remaining employees who

will not be placed in other federal jobs. The number of eliminated positions is multiplied by an average federal worker salary to determine annual recurring savings. A similar process is used to determine savings from eliminated military billets. [Ref. 33]

The model uses an exponential cost function to estimate recurring overhead savings. Overhead savings are separated into two types, maintenance of real property (MRP) and other base operating support (OBOS). For maintenance of real property (MRP), the overhead cost function takes the form: Cost = $a*X^b$, where X is the number of square feet of facilities and a and b are constants determined from historical data. The same functional form is used for other base operating support (OBOS); in this case the variable X is the number of military and civilian employees. As in the previous case, the constants a and b are determined from historical data.[7] [Ref. 34]

E. SUMMARY

In summary, COBRA is a cost-benefit analysis tool that has been used by the military and the Base Realignment and Closure Commission to evaluate the economic value of base closure decisions. The standardized approach of the model has allowed

[7] The original version of COBRA used by the 1988 Commission used a simple linear model for overhead costs because the Services were not able to develop the data required to estimate the constants a and b.

the Commissions to analyze a large number of closure scenarios, but perhaps at the cost of accuracy. This chapter provided explanations of the model's net present value approach and calculational methods that will serve as the background for further analysis of the model.

The GAO, CBO, and several DOD agencies have reviewed COBRA and have made recommendations that have resulted in improvements and additions to the model. A survey of these previous analyses is the subject of the next chapter.

IV. PREVIOUS STUDIES OF COBRA

A. INTRODUCTION

This chapter surveys the previous studies of the COBRA model performed by the General Accounting Office (GAO), the Institute for Defense Analyses (IDA), and the Center for Naval Analyses (CNA). The chapter is divided into five sections, including this Introduction. Section B describes the previous GAO studies of the model and summarizes the changes made to the model as a result of GAO recommendations. Section C discusses the IDA analysis of COBRA that resulted from a review of the cost savings due to the realignment of naval laboratories. Section D provides the results of the CNA analysis of the model. The final section summarizes the key findings of these studies.

B. GENERAL ACCOUNTING OFFICE

The General Accounting Office has conducted most of the previous studies of the COBRA model; and has analyzed the model during or just after the deliberations of the three Base Realignment and Closure Commissions. The GAO first studied the model in 1989, in response to a request from the House and Senate Armed Services Committees for an evaluation of the 1988 Commission's methodology and recommendations. GAO analyzed the model again in 1991 and 1993 as part of the base closure

selection process[8]. Each of these studies has produced a set of recommended changes to the model, many of which were implemented prior to the subsequent round of base closure decisions.

In its 1989 study of the Commissions closure recommendations, the GAO concluded that the COBRA model "is a conceptually sound tool for evaluating costs, savings, and payback periods." [Ref. 35] However, GAO also found several deficiencies in the model. These deficiencies included 1) the exclusion of some relevant costs, 2) the use of improper discount and inflation rates, and 3) errors in the data input. [Ref. 36]

The report identified several base closure costs that are not funded from the DOD accounts but are nevertheless costs to the government. The study gave as an example the increase in Medicare costs that may occur when a military hospital is closed and retirees that were formerly treated at the hospital migrate to the Medicare system. The 1989 COBRA model did not include Medicare costs (or any other non-DOD costs) because they were not paid from DOD funds. The GAO considered these costs relevant to base closure and stated "...that studies of

[8] The 1990 Defense Base Closure and Realignment Act requires GAO to analyze the Defense Department's selection process and methodology during each Base Closure and Realignment Commission. Its reports have always included analyses of the costs/savings estimates and the COBRA model.

base closures should consider costs on a governmentwide basis." [Ref. 37]

The report also identified costs funded from DOD accounts that the DOD believes should not be considered in the COBRA model. By far the largest of these are environmental cleanup costs, which were estimated at $661 million (1989 dollars) for the 1988 BRAC round [Ref. 38]. The GAO reported that DOD did not consider these costs to be a consequence of base closure since it is responsible for cleanup of all bases regardless of closure decisions. The GAO agreed with this approach; however, it pointed out that the costs were "substantial." [Ref. 39]

In addition, the report stated that the discount and inflation rates used by the model were too conservative. It proposed using a 9 percent discount rate and 4.4 percent inflation rate (based on 1989 indexes) instead of the 10 percent discount rate and 3 percent inflation rate used by the BRAC. The GAO noted that these factors had "little impact" [Ref. 40] on individual base payback periods; however, they do increase the net present value of the base closure savings.

The GAO analysts found many data entry errors during their review of the 1988 COBRA estimates. They gave as an example the case of Norton Air Force Base. The Commission decided to leave the family housing area at the base open, but the Air Force application of the model assumed that the family housing

would be closed. The analysts proposed that the insufficient time allotted to the BRAC process contributed to data accuracy problems, and that allowing sufficient time for the Commission to oversee data gathering and analysis would improve the cost estimates. [Ref. 41]

The GAO analyzed the COBRA model again in 1991 as part of its report to Congress on the DOD's base closure selection process. This report identified some of the same issues previously raised in 1989--excluding Medicare cost increases, choice of discount and inflation rates, and various data input errors. The report reiterated the GAO belief that environmental cleanup costs should be excluded from COBRA, but noted that the large costs had significant budgetary effects. It also pointed out several previously undiscovered problems with the flexibility and the calculational methods of the model. [Ref. 42]

The flexibility issue was raised because the military departments experienced difficulties entering some specific cost data. Air Force analysts provided detailed engineering cost estimates for their military construction, but were unable to enter these costs directly into the model. They also provided detailed base-by-base estimates for CHAMPUS cost increases, but again were unable to enter the data. The analysts were forced to devise a "workaround" solution; they developed artificial input data that forced COBRA to produce

construction and CHAMPUS cost estimates to match their detailed estimates. [Ref. 43]

The GAO also reported several problems with the model algorithms for moving costs and the costs of operating family housing. The 1991 model assigned the same costs for moving military students as for PCS moves. This caused the one-time costs for bases with student populations to be overstated. Also, the model treated family housing operations costs as fixed. The GAO analysts did not believe this was realistic; they proposed that operating costs should decrease at a closing base and increase at a receiving base when new housing is built. [Ref. 44]

After the 1991 BRAC round, representatives from the Office of the Secretary of Defense and each of the military departments formed a working group to address the weaknesses of the model and make improvements to the model prior to the 1993 BRAC. As a result, the current version (vers. 4.04) of COBRA was developed. [Ref. 45] The improvements to the model are summarized in Table I [Ref. 46].

The GAO report on the 1993 base closure selection process included an analysis of the revised COBRA (vers. 4.04) model. The analysis found that many of the problems identified in previous studies had been corrected; however, some issues, such as the exclusion of Medicare costs, still remained. The study also raised two new issues. The algorithms and programming of the newest version have not been independently

verified. In addition, the Defense Logistics Agency (DLA) experienced significant problems when it tried to use the model to calculate overhead savings from consolidations. [Ref. 47]

Table I IMPROVEMENTS TO THE COBRA COST MODEL

Weaknesses and limitations in 1988 and 1991	**1993 cost model features**
Formulas: user may alter.	Users cannot alter formulas.
MILCON: Actual costs of construction cannot be entered.	Military construction costs can be entered.
Data entry: Data entry format is limited and net result is inaccurate data.	Data entry format problems are eliminated.
Health care costs: % of retirees liable for Medicare at each installation should be entered.	% of retirees eligible for Medicare can be entered into the model for each installation analyzed.
Multibasing capability: Model needs an expanded capacity to include more losing and gaining bases.	Model allows 15 bases to be included in the scenario as losers, gainers, or both.
Family housing: Operations cost of family housing not fully considered.	Model estimates family housing operation savings at losing bases and cost increases at gaining bases.
Land sales: Revenue from land sales is difficult to estimate.	Analyses rarely include land sales.
Documentation: Model has not been documented.	Model is documented in a user's manual, algorithm manual, and programmer's manual.

In summary, the previous GAO studies have led to improvements in the model, but have not resolved all of the significant issues. The exclusion of non-DOD costs such as Medicare, the choice of discount and inflation rates, and the budgetary effects of the huge cost of environmental cleanup are still contentious issues.

C. INSTITUTE FOR DEFENSE ANALYSES

In 1991, the Institute for Defense Analyses (IDA) analyzed the COBRA model as part of a review of the costs and savings due to DOD laboratory realignments. IDA reviewed the methodology and the assumptions of the COBRA model and made detailed investigations of the costs/savings estimates for a selected set of the installations scheduled for consolidation. The IDA analysts identified several limitations with the model, but concluded that these limitations collectively were not critical enough to alter significantly the COBRA cost and savings estimates. [Ref. 48]

The IDA study noted four principal limitations of the COBRA model:

> First, documentation has not been updated since 1989 even though there have been about 30 modifications to the model since that time. Second, the data base that supports the standard factors used in the model is very limited,.... Third, COBRA is not designed to handle simultaneous realignment of multiple installations. Fourth, the COBRA structure cannot be easily modified to accommodate facts of life in lieu of standard factors; this leads to workarounds that defeat the purpose of a standard model. [Ref. 49]

The IDA proposed that these limitations "should be corrected to enhance model utility in future realignment and closure reviews." [Ref. 50]

Two of these issues have been completely resolved. The documentation for the model has been improved since the IDA study. R & K Engineering published a user's manual, an algorithm manual, and a programmer's manual in time for use by the 1993 BRAC. In addition, the COBRA model (vers. 4.04) has been modified to allow up to 15 bases to be included in a single base closure scenario [Ref. 51].

The development of a data base for the standard factors used in the COBRA model is a much more complex issue. The IDA study suggested that the absence of a data base for COBRA's standard factors opens the model to criticism from opponents of a realignment or closure. It goes further to propose that a "...good supporting data base would allow cost analysts to choose default factors based on particular economic and geographic assumptions." [Ref. 52] Unfortunately, the IDA study did not suggest how such a data base could be developed or what the source of the data should be.

The concern with COBRA's ability to "accommodate facts of life" [Ref. 53] was based on in-depth analysis of the COBRA estimates for laboratory realignments. IDA gives several examples of costs that COBRA did not accommodate, including costs for moving and recalibrating special research equipment. It also points out that COBRA could not accept detailed

engineering cost estimates for lab construction and did not allow the timing of the construction to be varied. Some of these problems are solved by the newest version of COBRA (vers. 4.04), that allows the user to enter a detailed construction cost estimate which overrides the COBRA construction algorithm. In addition, version 4.04 allows the user to enter special costs (like equipment recalibration costs) in a "unique one-time costs" data field.

D. CENTER FOR NAVAL ANALYSES

The Center for Naval Analyses conducted a quick review of the COBRA model during the 1991 BRAC process in response to a request from the Navy's Director of General Planning and Programming. In its report, analysts from the CNA concluded that, "Overall, the model should serve the purpose of examining the net savings from consolidating bases." [Ref. 54] However, they also pointed out several deficiencies in the model that included: 1) treatment of industrial activities, 2) exclusion of some relevant costs, and 3) choice of discount factors [Ref. 55].

The CNA study proposed that the 1991 version of the model was inadequate for estimating the costs and savings of consolidating industrial activities such as shipyards and aviation depots. It pointed out that the cost structure of industrial activities is different from the "typical military base" [Ref. 56] and therefore COBRA (which is based

on cost elements from bases that are not industrial activities) does not capture all of the significant costs/savings of closing/realigning industrial activities. The study discusses several of these costs and savings not addressed in the model, including:

- labor cost differentials associated with moving from high-cost to low cost regions,
- transportation and setup/calibration costs for specialized production equipment,
- costs/savings due to the effects on the supply pipeline and logistics network, and
- cost increases due to slowdowns in production during the moving process. [Ref. 57]

Furthermore, the CNA analysts proposed that the COBRA model excluded other significant costs/savings that are relevant to nearly all base closures/realignments. They stated that land sales proceeds should have been included in the 1990 version of the model as they had been in the original 1988 version. They also suggested that the change in federal contributions to school systems for support of dependent school children should be taken into account. Finally, they proposed that unemployment compensation costs should be included as a cost of closing bases. [Ref. 58]

The study also found, as had earlier GAO studies, that the proper discount and inflation rates had not always been used. Unlike the GAO studies, the CNA study did not propose a specific discount and inflation rate that should have been used. Rather it identified some cases where the OMB circular

governing economic analyses had not been followed, stating that the OMB guidance "appears to be the correct guide to follow." [Ref. 59]

In its summary, the CNA pointed out that the Navy limited its use of the COBRA model to a screening role. The Navy used the model solely as a means to demonstrate that proposed realignments and closures would save enough money to recoup the up-front costs. CNA pointed out that COBRA could be used as a preference decision tool to compare alternative strategies. The model could be used to compare the NPV and Payback Year of competing strategies "to identify the alternative with the higher economic payoff." [Ref. 60]

Changes made to the COBRA model for 1993 have addressed some of these findings; however, many issues still remain. The latest revision still does not include calculations of costs and savings which are unique to industrial activities, but the Navy still endeavors to include these in their costs/savings estimates for base closures. (The Navy practice is to calculate these costs/savings outside the model and then include them in COBRA estimates by entering them in the "unique" or "miscellaneous" costs/savings data fields available in COBRA [Ref. 61]). The current version of COBRA includes unemployment compensation costs; however, the proceeds from land sales and federal contributions to schools were not considered during the 1993 BRAC.

E. SUMMARY

The previous studies of the COBRA model have led to significant improvements to the model; however, some important issues remain unresolved. The latest GAO study pointed out that the model still excludes some relevant non-DOD costs. The IDA study expressed concern for the validity of the COBRA standard factor data base. The CNA report documented the limitations of the model when it is used for industrial activities, limitations which still exist. Furthermore, CNA and the GAO both questioned the discount and inflation rates used in the model. These and other unresolved issues are discussed in detail in the next chapter.

V. DATA PRESENTATION AND ANALYSIS

A. INTRODUCTION

This chapter presents an analysis of three critical aspects of the COBRA model: military construction cost estimates, prediction of overhead savings, and the choice of discount rate. The chapter is divided into five sections, including this introduction. Section B compares the actual military construction costs with COBRA estimates for three Navy installations recommended for closure by the first Base Realignment and Closure Commission. Section C analyzes the methods used by the COBRA model to calculate recurring overhead savings from base closures. Section D evaluates the discount rate used for the COBRA net present value analysis in light of Office of Management and Budget (OMB) guidance for benefit-cost analyses. Section E summarizes the key findings.

B. MILITARY CONSTRUCTION: ESTIMATES VERSUS ACTUAL COSTS

As stated in Chapter II, military construction costs are the largest component of the one-time costs of closing bases. Thus, accurate estimates of the construction costs are critical to the economic analysis of base closure decisions. The Institute for Defense Analyses study of laboratory realignments compared COBRA estimates of laboratory construction costs with the current plant value of similar

facilities [Ref. 62]. Previous GAO studies tested the sensitivity of COBRA net present value analysis to large changes in construction costs [Ref. 63]. However, no previous study has compared COBRA estimates with the actual construction costs for base closures.

Figure 4 presents a comparison of the COBRA cost estimates with the budgeted military construction costs for three base closings that are essentially complete. The sample bases are: Naval Station, Brooklyn; Naval Station, Sand Point; and Naval Station, Hunters' Point. They represent all of the Navy bases selected for closure/realignment during BRAC I for which nearly all the construction costs are known[9]. The construction costs and the COBRA estimates were converted to 1989 dollars for comparison. The budgeted costs for fiscal years 1990 through 1993 and the COBRA estimates are presented in Appendix A.

The base closures in the sample involved many different types of military construction projects. The closure of Hunters Point required the modification and improvement of several piers at the Pearl Harbor and San Diego Naval

[9] A portion of the military construction contracts originally required to support the closure of Naval Station Brooklyn have not been awarded. These contracts were for recreation facilities, a police station, a bachelor officers quarters, and storage facilities to be built at the Staten Island Naval Station. When the 1993 BRAC decided to close Staten Island, these projects were no longer required. The budget estimates of construction costs were used for these projects since the actual costs were not available.

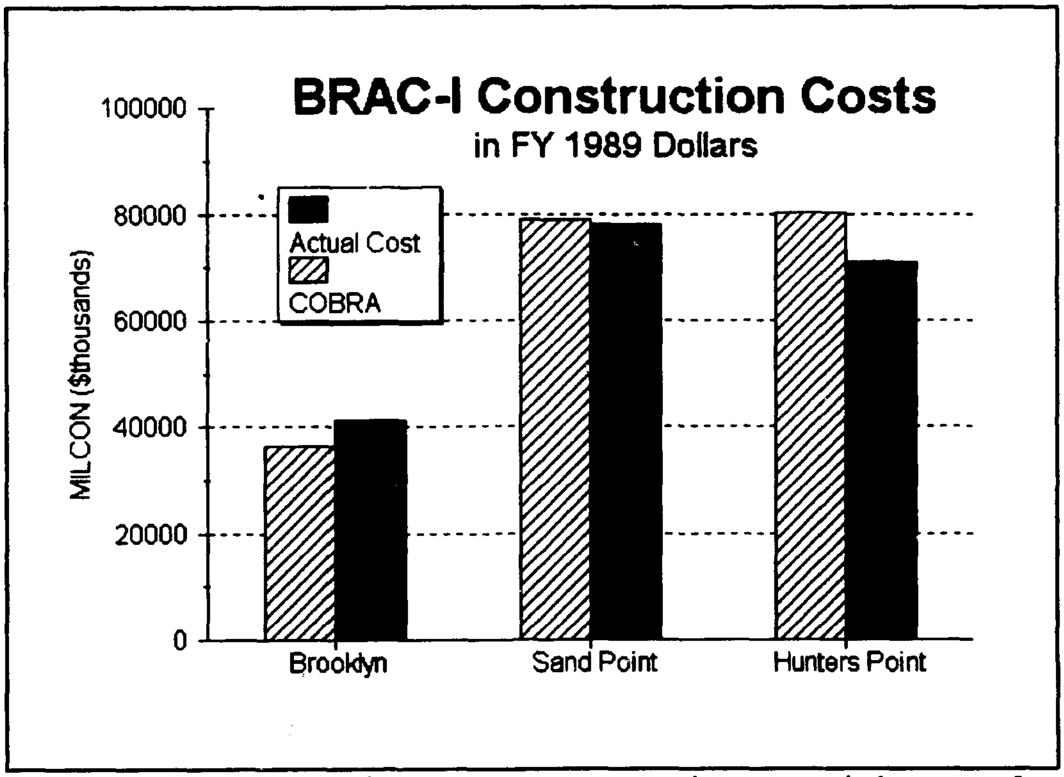

Figure 4 Comparison of COBRA Estimates with Actual Costs of Military Construction for BRAC I.

Stations. The realignment of Sand Point required construction of a headquarters/administration building, a commissary/exchange, a bachelor officers quarters, and several recreational buildings at the Everett, Washington Naval Station. The closure of Brooklyn called for construction of a public works center, a headquarters/administration building, a bachelor enlisted quarters, and a physical fitness center at the Staten Island Naval Station.

The COBRA estimates are all within the expected range for a parametric cost-estimating technique [Ref. 64]. The COBRA estimate for Brooklyn was $36.33 million, or 11.8

percent below the actual construction cost of $41.2 million. The estimate for Hunters Point was $80.37 million, or 12.9 percent above the actual construction cost of $71.16 million. The estimate for Sand Point was $79.13 million, or 1.3 percent above the actual cost of $78.08 million.

It should be noted that these are macroscopic comparisons of the total construction costs for each closure/realignment. This study was unable to verify that each of the finished construction projects matched exactly the specifications (square footage) used to derive the original COBRA estimates, because the detailed COBRA construction estimates from BRAC-I were not available. Although this study did not find any evidence to support it, the possibility exists that the scope of the construction projects may have been altered to keep MILCON spending within budgetary goals based on the COBRA estimates. However, interviews with officials at the Base Closure/Realignment Branch of the Director, Shore Activities (N44), who are responsible for the execution of the Base Closure Budgets, provided evidence that this was probably not the case. The Director (N444) stated that "...the budget estimates for military construction were developed without regard for the estimates provided by the COBRA model. COBRA estimates do not determine our budgets." [Ref. 65]

The sample size is too small to draw statistically significant conclusions about the accuracy of COBRA estimates for military construction costs. However, it is noteworthy

that the Navy COBRA model did not consistently under- or overestimate the actual costs of military construction, a small initial indication that the model does not produce systematic estimating errors.

As noted earlier, several modifications have since been made to improve the COBRA model, but it is noteworthy that the military construction cost calculation methods used in the 1989 version of COBRA remain essentially unchanged in the current version 4.04. The only difference between the 1989 and 1993 versions of the model are small changes in the values of the standard factors used in the formulae. Military construction standard factors for 1989 and 1993 are presented in Appendix A for comparison.

However, the 1993 version of COBRA allows the user to enter detailed engineering estimates of military construction costs if they are available. This should improve COBRA net present value analyses for the cases where detailed estimates are available, since detailed construction estimates are normally more accurate than estimates based on parametric formulas.

C. CALCULATION OF OVERHEAD SAVINGS

Overhead savings comprise a significant portion of the recurring savings achieved when closing bases, accounting for approximately 25 percent of the total annual savings (See Figure 2 in Chapter II). Thus, accurate estimation of

overhead savings is critical to the economic analysis of any base closure decision. This section analyzes the methods used by COBRA to calculate overhead savings.

As stated in Chapter III, COBRA uses two exponential functions to describe non-payroll overhead costs for all installations. Maintenance of Real Property (MRP) costs are predicted based on the square footage of the buildings/structures on the installation. Other Base Operating Support (OBOS) costs are predicted based on the total personnel (military and civilian) assigned to the base. The COBRA (version 4.04) algorithms[10] for calculating non-payroll MRP and OBOS costs are:

$$NewMRPCosts = OldMRPCosts * \left(\frac{NewBuildingSF}{OldBuildingSF}\right)^{RPMABuildingSFIndex}$$

$$NewOBOSCosts = OldOBOSCosts * \left(\frac{Newpopulation}{Oldpopulation}\right)^{BOSIndex}$$

The recurring non-payroll overhead savings for a base closure scenario are estimated in the following manner. The non-payroll overhead costs prior to the closure action are summed for all bases involved in the scenario. The non-payroll costs that these bases will incur after the closure action are then

[10] Algorithms are the set of formulas used in the computer model to calculate costs and savings. The RPMA Building SF Index and the BOS Index are entered as service-specific standard factors in the COBRA model. RPMA stands for Real Property Maintenance Activities and is equivalent to the Maintenance of Real Property (MRP) term used by the Navy. BOS stands for Base Operating Support and is equivalent to the Other Base Operating Support (OBOS) term used by the Navy.

predicted using the formulas above. The difference between the pre-closure overhead costs and the post-closure overhead costs represent the recurring overhead savings from a base closure action.

The Navy Base Structure Analysis Team (BSAT) estimated the values of the two constants, the RPMA Building SF Index and the BOS Index, by applying regression analysis to the MRP and OBOS costs for over 200 Navy installations in the U.S. and its territories [Ref. 66]. Figure 5 presents the Navy BSAT plot of MRP costs versus Building Square Footage for these installations. Figure 6 presents the Navy BSAT plot of OBOS costs versus Total Personnel. The data used by the Navy BSAT are provided in Appendix B.

The RPMA Building SF Index was determined from a linear regression of the logarithmic transform of the non-payroll MRP costs on the single predictor variable, the logarithmic transform of the building square footage. The BOS Index was determined from a linear regression of the logarithmic transform of the non-payroll OBOS costs on the single predictor variable, the logarithmic transform of the base population (total military and civilian personnel assigned). The analysis yielded an RPMA Building SF Index of 0.70 and a BOS Index of 0.81; the Navy used these values when preparing its COBRA estimates for the 1993 BRAC. The coefficient of determination (R-squared) for the MRP regression was 42

percent; R-squared for the OBOS regression was 53 percent [Ref. 67].

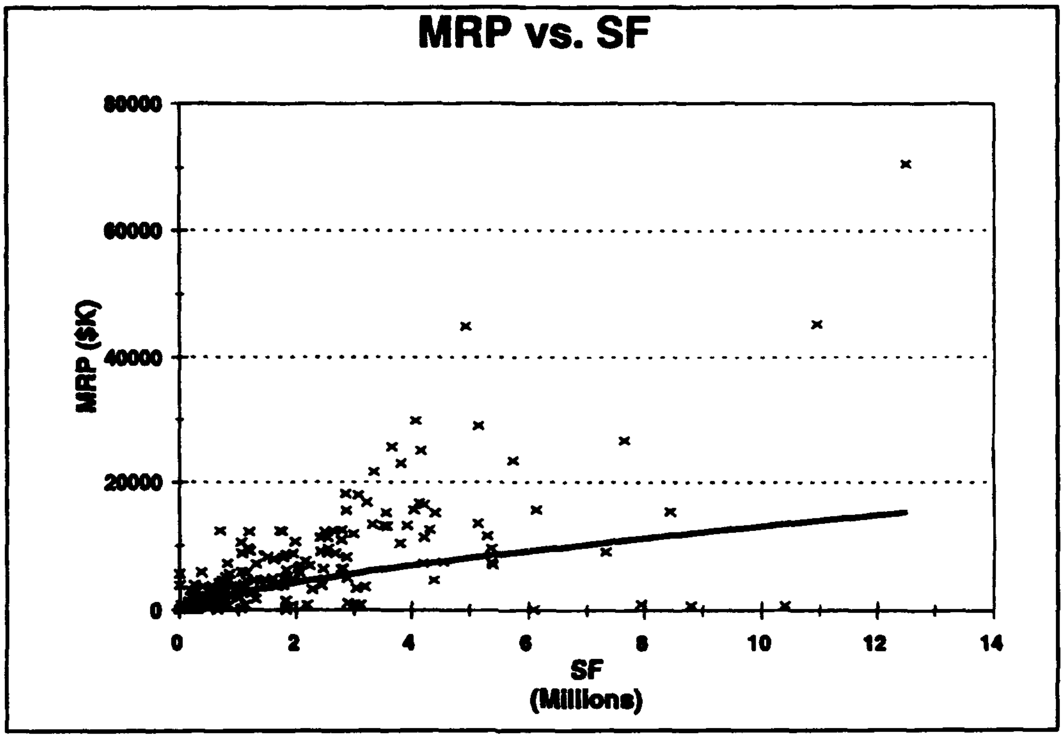

Figure 5 MRP Costs versus Building Square Footage for Navy/Marine Corps Bases (Source: Navy BSAT)

The COBRA method for estimating non-payroll overhead savings relies on two key assumptions about the nature of overhead costs at Navy/Marine Corps bases:

- MRP costs are an exponential function of the square footage of facilities for all installations.
- OBOS costs are an exponential function of base population for all installations.

Given the diverse missions and the differences in size of the many Navy and Marine Corps installations, one would reasonably question the validity of these assumptions. The relationship

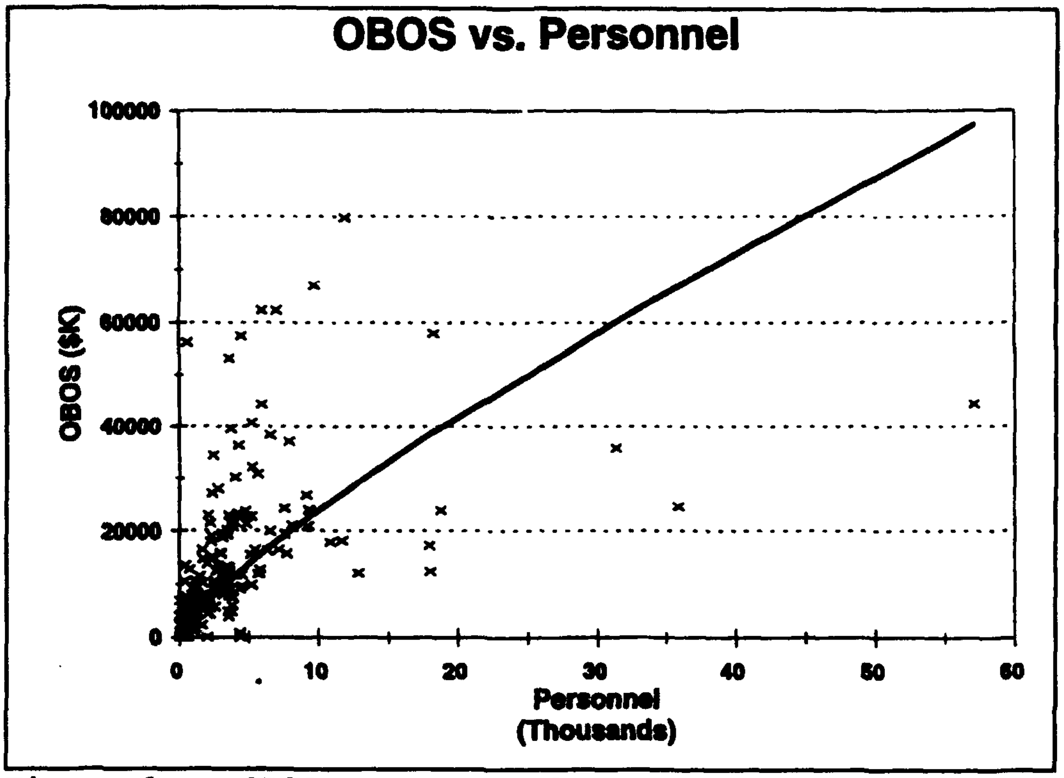

Figure 6 OBOS versus Total Personnel for Navy/Marine Corps Installations (Source: Navy BSAT)

between MRP costs and square footage at a naval hospital may be different than the MRP-square footage relationship at a naval air station because maintenance requirements for hospital facilities differ from the maintenance requirements for hangars and air-operations buildings. Furthermore, other variables such as the age of the facilities, the severity of the climate, or the type of buildings and structures may be better predictors of MRP costs. The relationship between OBOS costs and the total personnel assigned may also be different for installations of various sizes and missions.

To assess the effects of mission type on the overhead cost relationships, this study analyzed the MRP and OBOS costs for several categories of Navy/Marine Corps installations: naval hospitals, air stations, naval stations, naval shipyards, and communication facilities. The study found that the relationships between MRP costs and building square footage and between OBOS[*] costs and total personnel vary significantly between the categories of installations. The results are presented in Tables II and III. For some categories, the equations that best describe the overhead cost relationships differ significantly from the equations used in the COBRA model to calculate overhead costs. Thus it appears the COBRA model may not accurately predict overhead savings from base closures because it fails to take into account significant differences in overhead costs relationships between categories of installations.

Table II OBOS Cost Relationships for Navy/Marine Corps Bases ($thousands)

Type of Installation	Regression Model	Adjusted R-squared
Naval Hospitals	OBOS=-1236+3.73TP	79.5%
Air Stations	$OBOS = 383 \times TP^{.427}$	59.1%
Communication Sites	$OBOS = 4.66 \times TP^{.966}$	75.5%
Naval Stations	OBOS=11138+.505TP	61.5%
Naval Shipyards	$OBOS = 7.17 \times TP^{.949}$	39.0%

The regression models in Table II are equations that best describe the relationship between OBOS costs and the total personnel (TP) assigned to the base. These equations were developed by performing least squares regression analyses on the OBOS costs to determine the best fit line for each set of data. The adjusted R-squared[11] value given for each equation represents the percentage of the variation in the dependent variable (OBOS) that is explained by the regression model. In this regard, the closer the adjusted R-squared is to 100 percent, the better the regression model is for predicting OBOS costs as a function of total personnel.

Two possible regression models were examined for each of the five categories: a linear model and an exponential model. The linear model was produced by performing least squares regression of OBOS costs using total personnel as the predictor variable. The exponential model was produced by performing least squares regression on the logarithmic transform of the OBOS costs using the logarithmic transform of total personnel as the predictor variable. The adjusted R-squared values for the two models were compared to determine which model better described the relationship between OBOS costs and total personnel. The regression model which produced the highest adjusted R-squared is presented in Table II.

[11] The adjusted R-squared is used instead of R-squared because the values are corrected for the sample size.

Statistical-inferential procedures were performed to assess the significance of the slope and intercept coefficients of each regression model. The t-statistics[12] (or t-ratios) were calculated for each coefficient term and compared to critical values of the Student's t-distribution to determine if the coefficient was useful for predicting overhead costs. If the t-statistic was lower than the critical value from the t-distribution for the 5 percent level of significance, then the coefficient was considered insignificant to the regression model. In general, the higher the values of the t-statistic, the more useful a coefficient is for predicting costs.

The regression models in Table III were similarly produced. Regression analysis was performed on the MRP costs using square footage (SF) of facilities as the predictor variable to develop a linear model. An exponential model was produced by performing regression of the logarithmic transform of MRP costs using the logarithmic transform of square footage as a predictor variable. The model that better explained the MRP costs relationship, as measured by the adjusted R-squared, is presented in Table III.

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[12] The t-stat ic is defined as the ratio of the coefficient to the estimated standard deviation of the coefficient.

$$t=\frac{Coefficient}{stddev}$$

Table III MRP Cost Relationships for Navy/Marine Corps Bases ($thousands)

Type of Installation	Regression Model	Adjusted R-squared
Naval Hospitals	$MRP = 368 + .0037SF$	82.9%
Air Stations	$MRP = 0.44 \times SF^{.677}$	36.7%
Communication Sites	$MRP = .00155 \times SF^{1.04}$	91.8%
Naval Stations	$MRP = -1917 + .00615SF$	69.5%
Naval Shipyards	$MRP = 6125 + .0018SF$	16.7%

For the types of installations for which overhead costs vary linearly, the slope coefficient is critical for estimating changes in overhead costs when personnel or buildings are added or subtracted. The value of the slope represents the expected change in overhead cost (MRP or OBOS) for each unit increase in the predictor variable (square footage or total personnel). It is noteworthy that the slope coefficient for OBOS costs is much smaller for naval stations than for naval hospitals (Table I). This implies that addition of personnel to naval stations results in smaller increases in overhead costs than for hospitals.

For the types of installations for which overhead costs vary exponentially, the exponent of the predictor variable term is critical. The exponent of the predictor variable represents the percentage change in overhead costs (MRP or OBOS) for a unit increase in the predictor variable (square

footage or total personnel). For example, if the exponent of the total personnel term (TP) is 0.80, then a ten percent increase in personnel would cause OBOS costs to increase by 8 percent. It is noteworthy that the exponent for air stations OBOS costs (.427) is much smaller than for communication sites (.949). This reflects that much larger economies of scale exist for air stations than for communication sites.

The following subsections discuss the specifics of the regression analyses conducted for each of the five categories of installations. Appendix C provides a breakdown of non-payroll overhead costs by category of installation and the computer printout of the regression analyses.

1. NAVAL HOSPITALS

The sample consisted of 15 Navy hospitals with MRP budgets ranging from $320 thousand to $16.7 million. The OBOS budgets ranged from $397 thousand to $23.8 million.

The regression results indicate that a strong positive linear relationship exists between MRP costs and building square footage. Linear regression of MRP costs was performed using building square footage as the single predictor variable. The resulting regression equation is:

$$MRP(\$\,thousands) = 368 + 0.00371 * TotalSF$$

The coefficient of determination, or adjusted R-squared, for the regression is 82.9 percent. The t-statistics for the

intercept and slope coefficients are 0.62 and 8.30 respectively, indicating that the intercept is insignificant when describing MRP costs. The regression curve is shown in Figure 7.

Regression analysis shows that an exponential relationship between MRP costs and square footage is less supportable. A linear regression of the log transform of MRP costs was performed using the log transform of building square footage as the predictor variable. The resulting regression equation is:

$$\ln MRP(\$\,thousands) = -5.84 + 1.02 * \ln TotalSF$$

The adjusted R-squared for the log-log regression is 56.1 percent, significantly weaker than obtained for the linear model. The t-statistics for the intercept and slope were 1.88 and 4.35.

It should be noted that the coefficient of the ln Total SF term, 1.02, would be the RPMA Building SF Index for the sample installations (in this case Navy hospitals). Economies of scale are indicated when an installation's RPMA Building Index is less than 1.0. For example, an installation with an Index of 0.80 would experience only an 8 percent rise in MRP costs for every 10 percent increase in building square footage. A value of 1.02 indicates that significant economies of scale (with regard to MRP costs as a function of building square footage) do not exist for Navy hospitals.

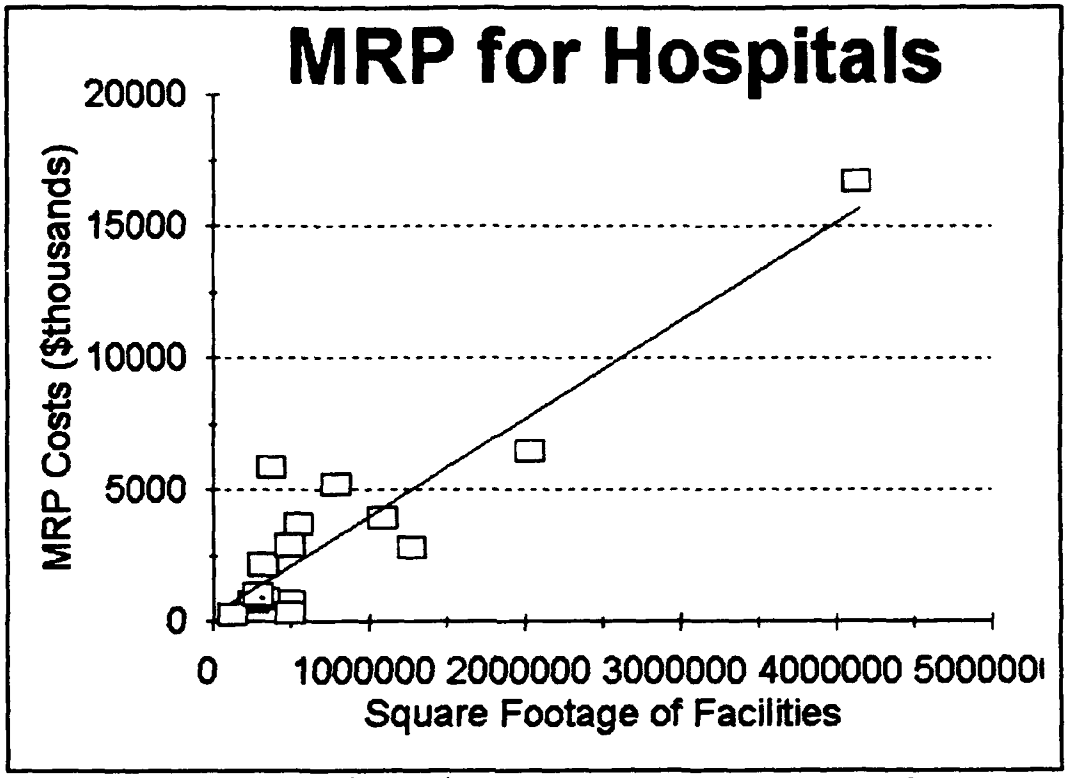

Figure 7 Relationship Between MRP Budget and Building Square Footage for Navy Hospitals

The regression results indicate a strong positive linear relationship between OBOS costs and total personnel at naval hospitals. Linear regression of OBOS costs was performed using total personnel as the single predictor variable. The resulting regression equation is:

$$OBOS(\$thousands) = -1236 + 3.73 * TotalPersonnel$$

The adjusted R-squared is 79.5 percent. The t-statistics for the intercept and slope are 1.09 and 7.43, indicating the slope coefficient is more significant in the linear model. The regression curve is shown in Figure 8.

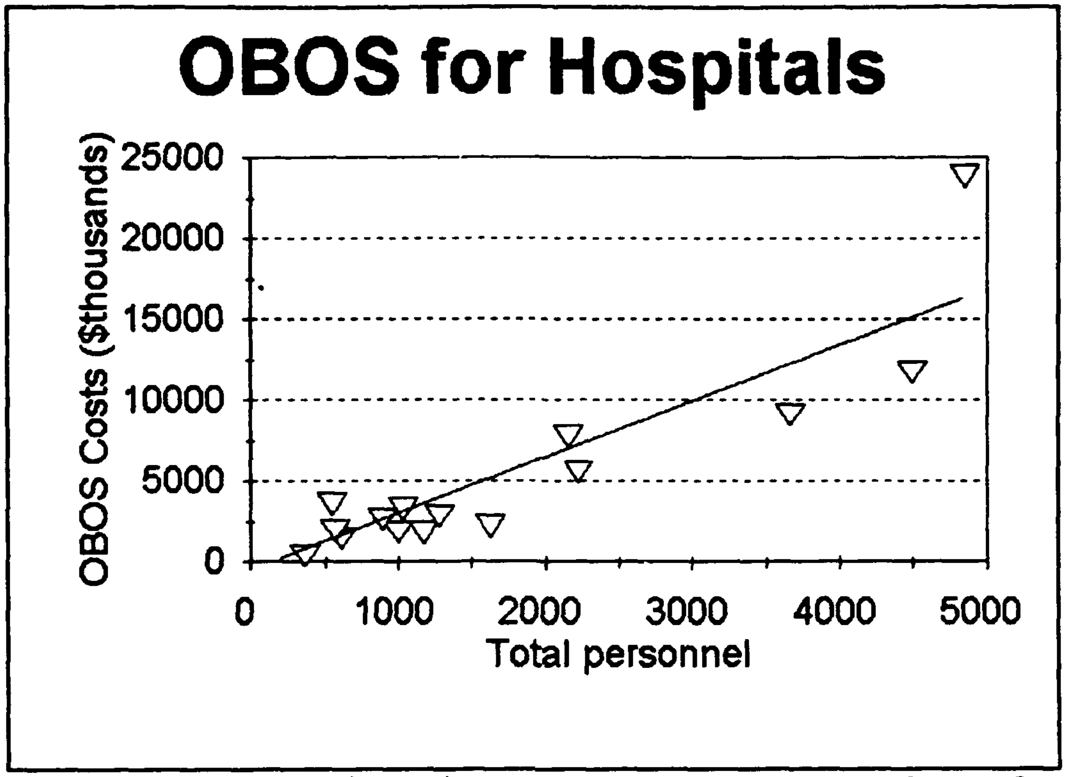

Figure 8 Relationship Between OBOS Costs and Total Personnel for Naval Hospitals

The possibility of an exponential relationship between OBOS costs and total personnel was also explored. A linear regression of the log transform of OBOS costs was performed using the log transform of total personnel as the single predictor variable. The resulting regression equation is:

$$\ln OBOS(\$thousands) = 0.16 + 1.11 * \ln TotalPersonnel$$

The coefficient of determination is 76.5 percent, nearly as high as for the linear function. The t-statistics for the intercept and slope are 0.14 and 6.83, indicating the intercept coefficient is not significant in the log-log model.

The coefficient of the ln total personnel term would be the OBOS Index for Naval Hospitals. Since the value 1.11 is greater than 1, the data indicate that some diseconomies of scale (with regard to OBOS costs as a function of personnel) may exist for Navy hospitals.

2. COMMUNICATION FACILITIES

The sample consisted of seven Navy communications facilities with MRP budgets ranging from $20 thousand to $1.7 million. The OBOS budgets ranged from $202 thousand to $8.4 million.

The regression results indicate the MRP costs at communication sites may best be described as an exponential function of building square footage. Linear regression of the log transform of MRP costs was performed using the log transform of building square footage as the single predictor variable. The resulting regression equation is:

$$\ln MRP(\$\,thousands) = -6.47 + 1.04 * \ln TotalSF$$

The adjusted R-squared for this model is 91.8 percent, indicating a strong correlation. The t-statistics for the intercept and slope are 4.29 and 8.27, so it appears both coefficients are significant. The regression curve is shown in Figure 9. The coefficient of the ln Total SF term (1.04) indicates that economies of scale (with respect to MRP costs as a function of building square footage) probably do not exist for communication facilities.

Linear regression of the MRP costs was performed using building square footage as the single predictor. The resulting regression equation is:

$$MRP(\$\,thousands) = -15.2 + .00283\,TotalSF$$

The adjusted R-squared is 81.0 percent, slightly weaker than the 91.8 percent obtained for the log-log regression. The t-statistics for the intercept and slope coefficient are 0.09 and 5.15, indicating that the intercept is not significant.

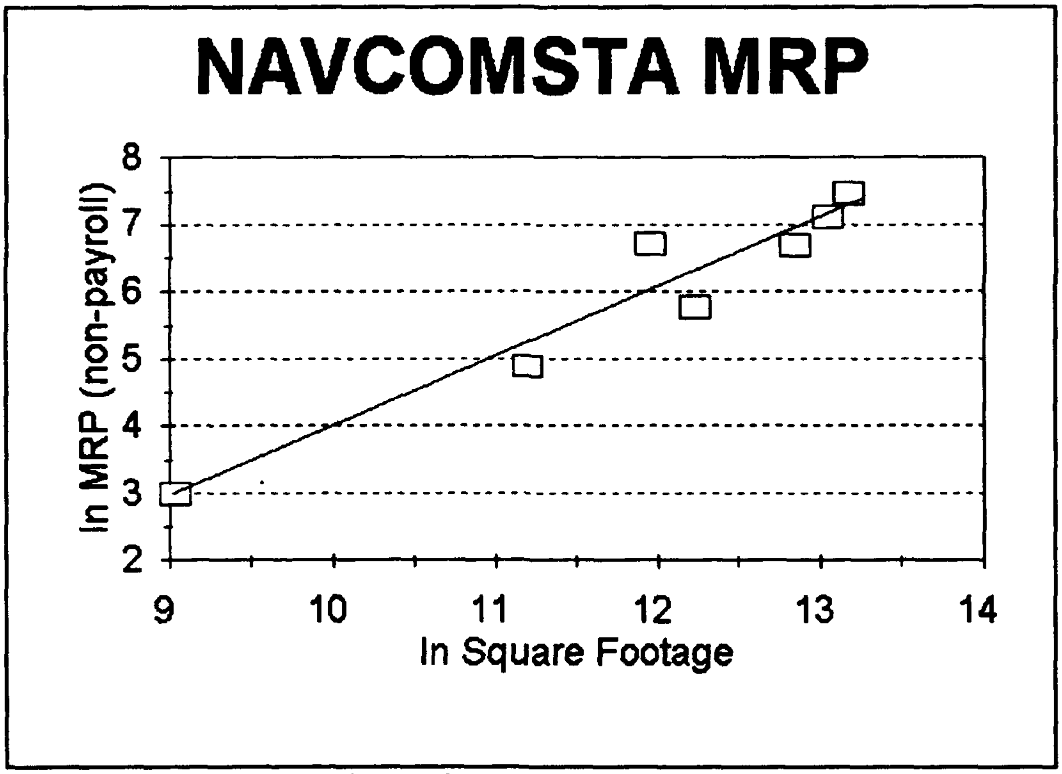

Figure 9 Relationship Between MRP Budget and Building Square Footage for Navy Communication Sites

Regression analysis indicates that OBOS costs at communication sites may best be described as an exponential

function of the total personnel assigned to the site. The regression of the log transform of OBOS costs using the log transform of Total Personnel as the single predictor produces the following regression equation:

$$\ln OBOS(\$ thousands) = 1.54 + 0.966 * \ln TotalPersonnel$$

The adjusted R-squared is 75.5 percent. The t-statistics for the intercept and slope coefficients are 1.11 and 4.42. The regression curve is shown in Figure 10. The coefficient of the ln Total Personnel term (0.966) is slightly less than 1.0, indicating that very small economies of scale (with respect to OBOS costs as a function of total personnel) may exist for communication facilities.

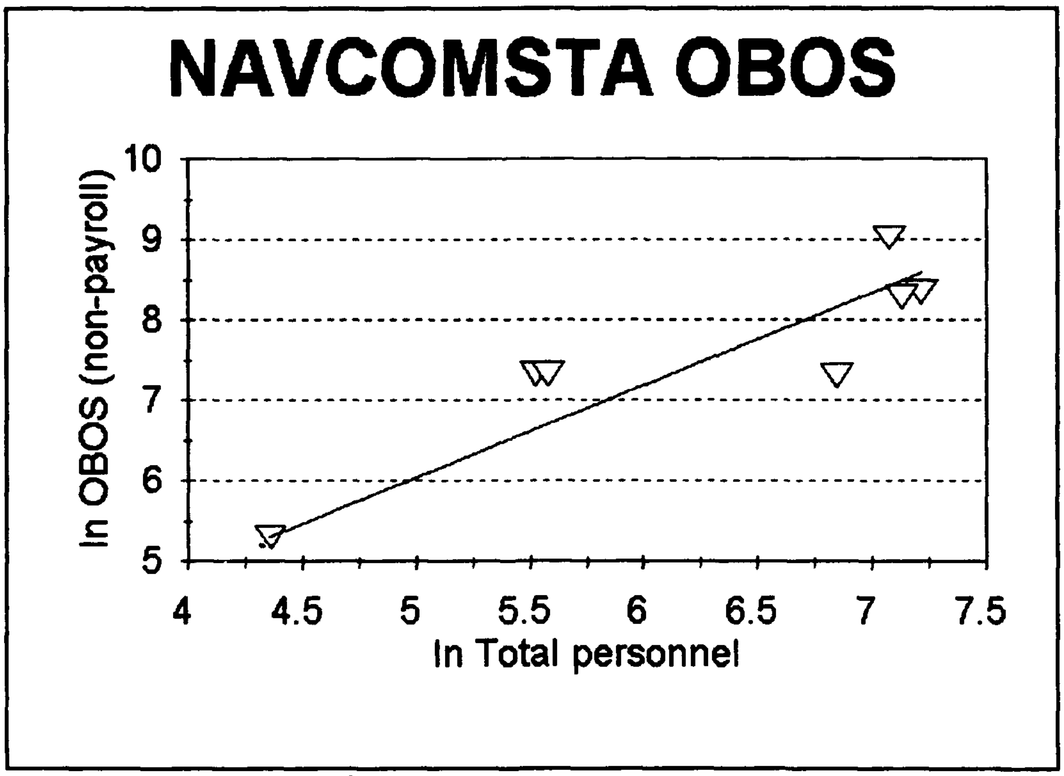

Figure 10 Relationship Between OBOS Costs and Total Personnel for Navy Communications Sites

Regression analysis shows that a linear relationship between OBOS costs and Total personnel is less supportable. Linear regression of OBOS costs using total personnel as the single predictor produces the following regression equation:

$$OBOS(\$thousands) = 228 + 3.72 * TotalPersonnel$$

The adjusted R-squared is 44.9 percent, weaker than the 75.5 percent obtained for the log-log regression. The t-statistics for the intercept and slope are 0.16 and 2.43, indicating that the intercept is not significant to the model. It is noteworthy that the coefficient of total personnel (3.72) is nearly the same as for the linear relationship describing OBOS costs at naval hospitals (3.73).

3. NAVAL SHIPYARDS

The sample consists of seven naval shipyards with non-payroll MRP budgets ranging from \$3.35 to \$26.7 million. The non-payroll OBOS budgets ranged from \$12.8 to \$79.7 million.

The results of the regression analysis indicate a weak linear correlation between MRP costs and the square footage of the facilities. Linear regression of MRP costs using building square footage as the single predictor variable produces the following regression equation:

$$MRP(\$thousands) = 6125 + 0.00179 TotalSF$$

The adjusted R-squared is 16.7 percent, indicating a weak correlation between MRP and building square footage. The t-

statistics for the intercept and slope coefficients are 0.96 and 1.48; neither coefficient can be accepted at the 5 percent significance level.

A linear regression of the log transform of MRP costs using the log transform of the building square footage as the predictor variable was also performed. The resulting regression equation is:

$$lnMRP=-2.65+0.791*lnTotalSF$$

The R-squared is 16.2 percent comparable to the value obtained for the linear model. The t-statistics for the intercept and slope are 0.32 and 1.47. Figure 11 shows the log-log regression curve. Unlike the case for naval hospitals and communication sites, the coefficient of the ln Total SF term (0.791) indicates that economies of scale (with regard to MRP costs as a function of square footage) do exist for naval shipyards.

The relatively small values of R-squared and the t-statistics obtained for both the linear and the log-log regressions indicate that neither the linear nor exponential model are reliable for predicting MRP costs at shipyards. Perhaps other variables (e.g., drydock capacity) should be explored as possible predictors of MRP costs.

Regression analysis indicates an exponential model is slightly preferable to a linear model for describing OBOS costs at shipyards. A linear regression of the log transform

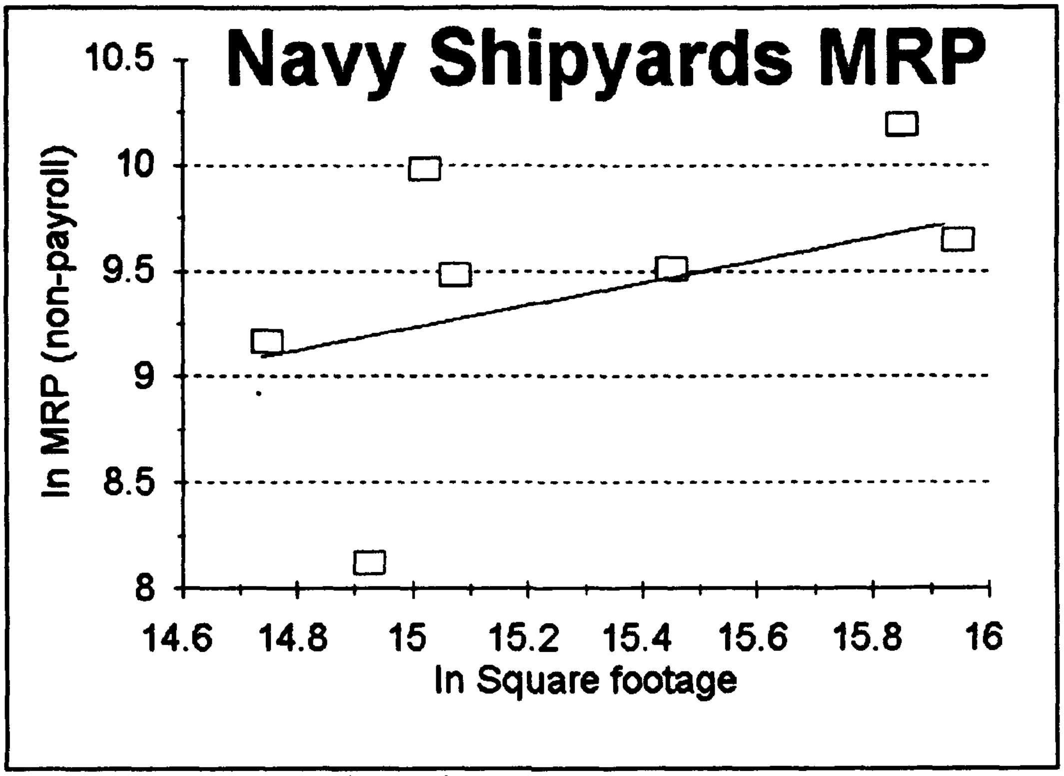

Figure 11 Relationship Between MRP costs and Building Square Footage for Navy Shipyards

of OBOS costs was performed using the log transform of Total Personnel as the single predictor variable. The resulting regression equation is:

$$\ln OBOS(\$thousands) = 1.97 + 0.949 * \ln TotalPersonnel$$

The adjusted R-squared is 39.0 percent for the log-log regression. The t-statistics for the intercept and slope are 0.51 and 2.20. The intercept coefficient is insignificant and the slope coefficient can be accepted at the 10 percent significance level. The coefficient of the ln Total Personnel term (0.949) is slightly less than 1.0; indicating that small

economies of scale may exist for shipyards. Figure 12 shows the regression curve.

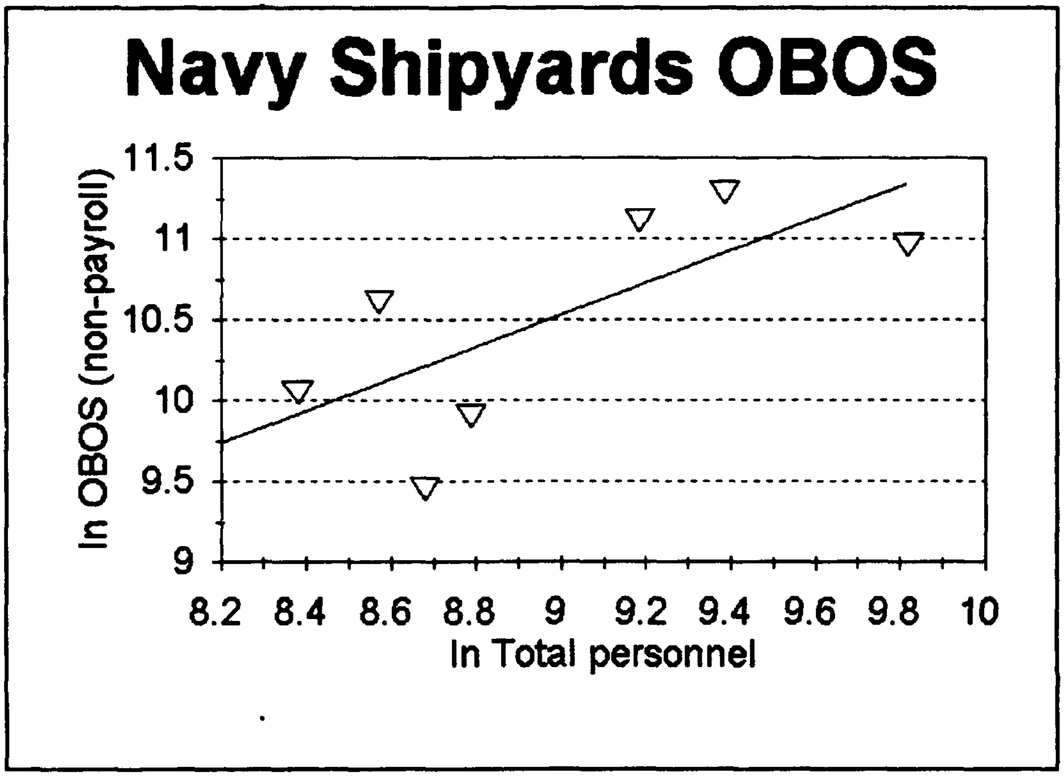

Figure 12 Relationship Between OBOS Costs and Total Personnel for Navy Shipyards

The existence of a linear correlation between OBOS costs and the number of personnel assigned is less supportable. The linear regression of OBOS costs using total personnel as the single predictor variable results in the following regression equation:

$$OBOS(\$thousands) = 12182 + 3.48 * TotalPersonnel$$

The adjusted R-squared is 34.0 percent, slightly inferior to the value for the log-log regression. The t-statistics for the intercept and slope coefficients are 0.71 and 2.02.

However, it is noteworthy that the coefficient of the Total Personnel term (3.48) is close to the value obtained for the linear models of OBOS costs at hospitals and communication sites.

4. NAVY/MARINE CORPS AIR FACILITIES

The sample consisted of thirty-one Navy/Marine Corps Air Stations with non-payroll MRP budgets ranging from $1.9 to $44.9 million. Non-payroll OBOS budgets ranged from $4.1 to $35.8 million.

The regression results indicate an exponential model is preferable to a linear model for describing MRP costs as a function of building square footage. Linear regression of the log transform of the MRP costs using the log transform of building square footage as the predictor variable yielded the following regression equation:

$$\ln MRP(\$\,thousands) = -0.82 + 0.677 * \ln TotalSF$$

The adjusted R-squared is 36.7 percent. The t-statistics for the intercept and slope coefficients are 0.35 and 4.29, indicating the intercept is insignificant in the log-log model. The regression curve is shown in Figure 13. The coefficient of the ln Total SF term (0.677) is less than 1.0, indicating that significant economies of scale (with respect to MRP costs as a function of building square footage) exist for air stations.

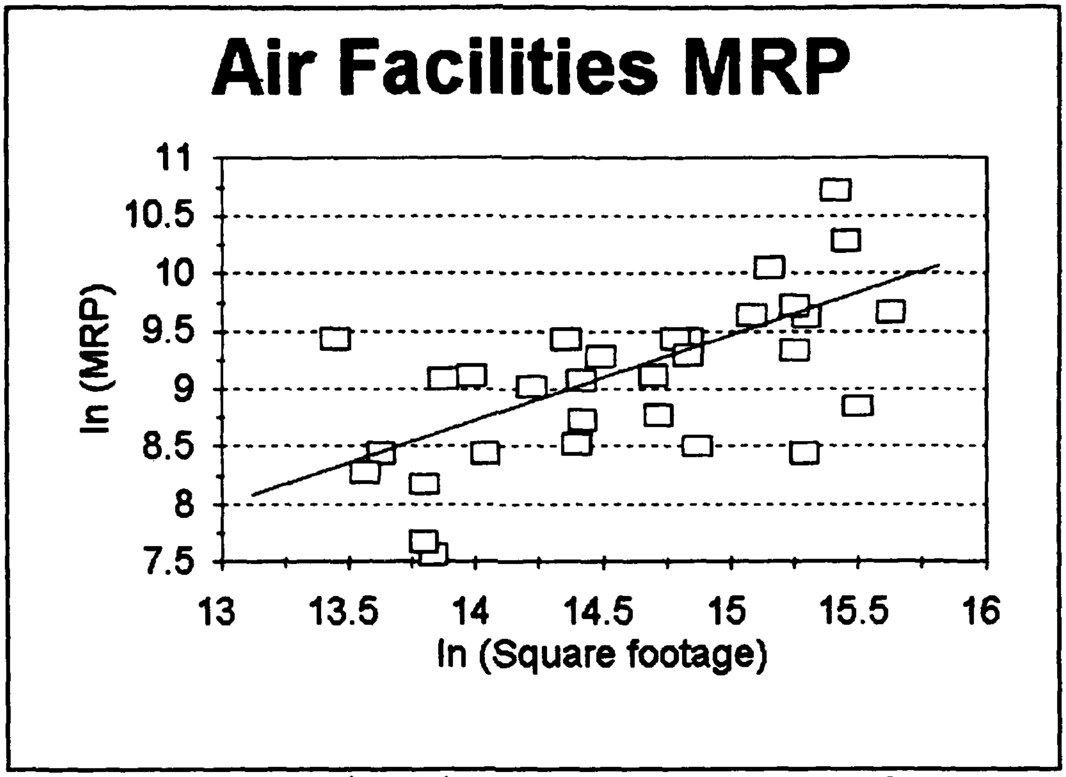

Figure 13 Relationship Between MRP Costs and Building Square Footage for Navy/Marine Corps Air Facilities

Regression analysis indicates that a linear relationship between MRP costs and building square footage is less supportable. Linear regression of MRP costs using building square footage as the predictor variable yielded the following regression equation:

$$MRP(\$thousands) = 2424 + .00325 * TotalSF$$

The adjusted R-squared is 32.8 percent, slightly inferior to the value obtained for the log-log regression.

Regression analysis indicates that OBOS costs are best described as an exponential function of the total personnel

assigned. Linear regression of the log transform of the OBOS costs using the log transform of total personnel as the predictor variable yielded the following regression equation:

$$\ln OBOS(\$ thousands) = 5.95 + 0,427 * TotalPersonnel$$

The adjusted R-squared is 59.1 percent, indicating a relatively strong correlation. The t-statistics for the intercept and slope coefficients are 11.51 and 6.66. Thus, it appears the intercept and slope coefficients are both significant in this model. Figure 14 shows the regression curve. The coefficient of the ln Total Personnel term (0.427) is significantly less than 1.0; indicating that significant economies of scale (with respect to OBOS costs as a function of total personnel) exist for Navy/Marine Corps air stations.

The case for a linear relationship between OBOS costs and total personnel assigned is not as strong. Linear regression of OBOS costs using total personnel assigned as the predictor variable gives the following regression equation:

$$OBOS(\$ thousands) = 9013 + 0.899 TotalPersonnel$$

The adjusted R-squared is 51.5%, smaller than the coefficient obtained for the log-log regression. It is noteworthy that the coefficient of the Total Personnel term (0.899) is much smaller than the coefficients obtained for the linear models for OBOS at hospitals, communication sites and shipyards; indicating a lower OBOS cost per person assigned.

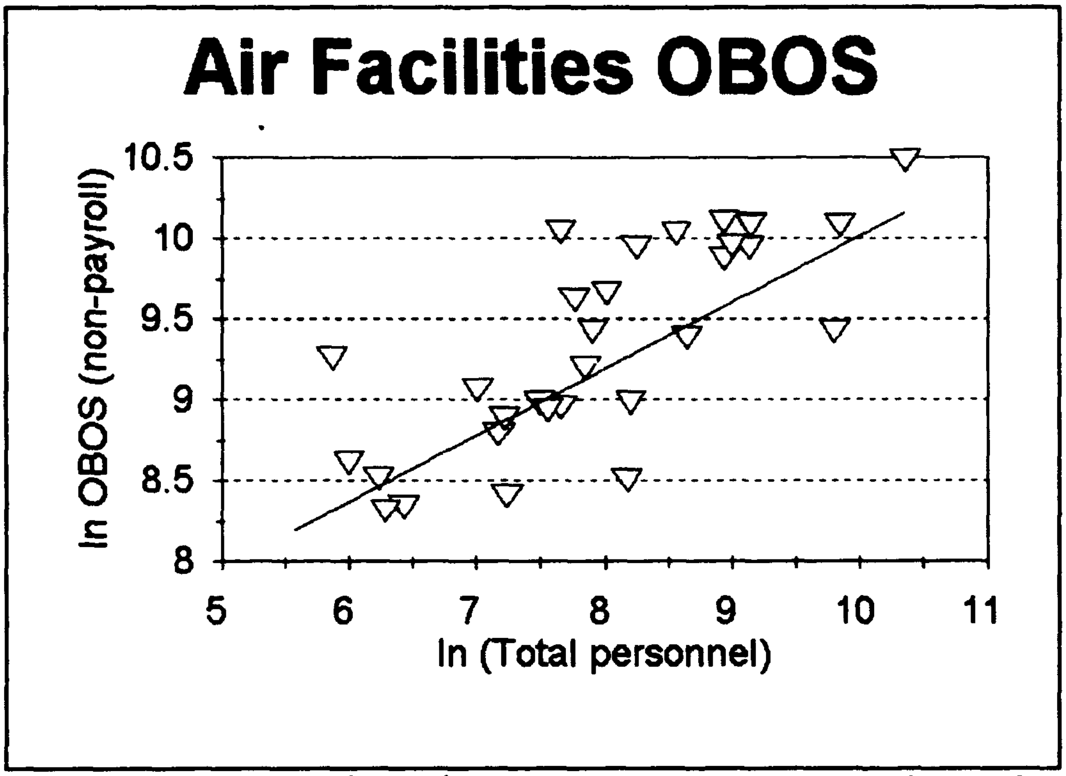

Figure 14 Relationship Between OBOS Costs and Total Personnel for Navy/Marine Corps Air Facilities

5. NAVAL STATIONS

The sample consists of a group of 9 naval stations with non-payroll MRP budgets ranging from \$1.75 to \$18.2 million. Their non-payroll OBOS budgets ranged from \$4.3 to \$44.4 million.

Regression analysis indicates that a linear model is preferable to an exponential model for describing the relationship between MRP costs and building square footage. Linear regression of the MRP costs using building square

footage as the predictor variable gives the following regression equation:

$$MRP(\$thousands) = -1917 + 0.00615 * TotalSF$$

The adjusted R-squared is 69.5 percent; indicating a relatively strong linear correlation between MRP costs and building square footage. The t-statistics for the intercept and slope coefficients are 0.60 and 4.39, indicating the intercept term is not significant. The regression curve is shown in Figure 15.

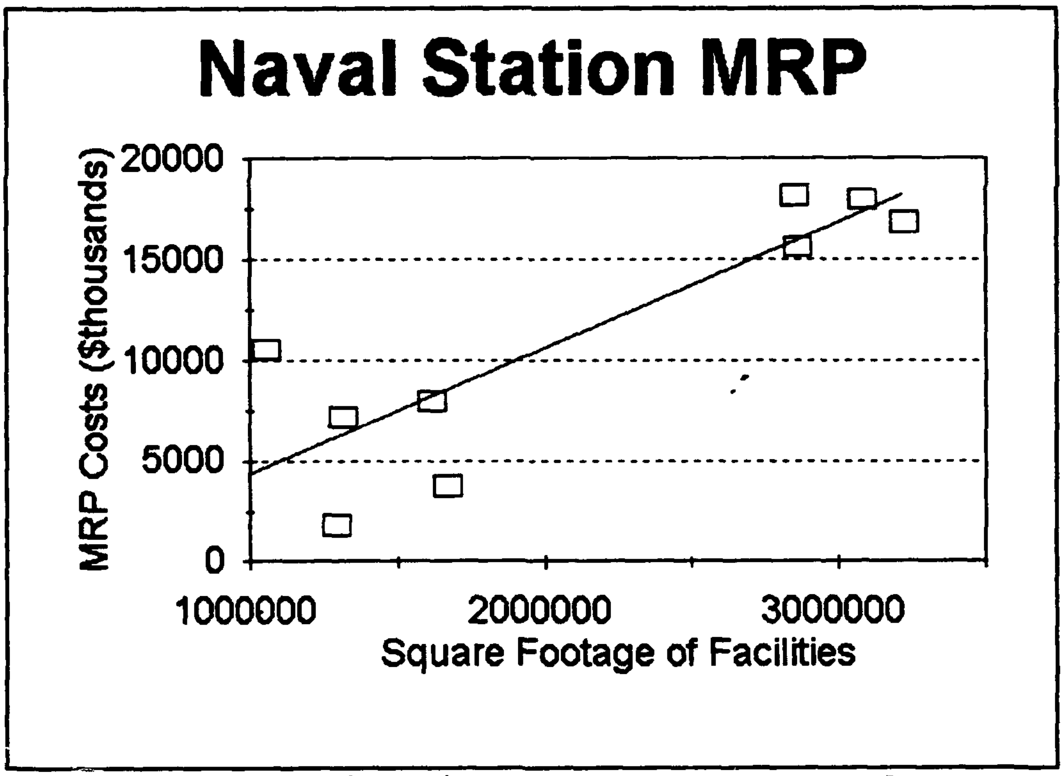

Figure 15 Relationship Between MRP Costs and Building Square Footage for Naval Stations

The regression results indicate an exponential model is not as supportable. Linear regression of the log transform of MRP costs using the log transform of building square footage as the predictor variable results in the following regression equation:

$$\ln MRP(\$thousands) = -9.42 + 1.28 * \ln TotalSF$$

The coefficient of determination is 39.9 percent; significantly weaker than the 69.5 percent obtained for the linear model. Note that if this exponential model were used to describe MRP costs, the coefficient of the ln Total SF term (1.28) would indicate significant diseconomies of scale for naval stations.

A linear model appears to be preferable to an exponential model for describing the relationship between OBOS costs and total personnel assigned at naval stations. Linear regression of OBOS costs using total personnel as the predictor variable yields the following regression equation:

$$OBOS(\$thousands) = 11138 + 0.505 TotalPersonnel$$

The adjusted R-squared is 61.5 percent, indicating a relatively strong linear correlation. The t-statistics for the intercept and slope coefficients are 3.41 and 3.71, thus both the intercept and slope are significant. The regression curve is shown in Figure 16. The y-intercept (11138) indicates that a large portion of the OBOS costs are fixed. Furthermore, the coefficient of the Total Personnel term

(0.505) is much smaller than for the linear models for OBOS costs at hospitals, communication sites, and shipyards. The lower cost per person reflects that the population of naval stations is usually much larger.

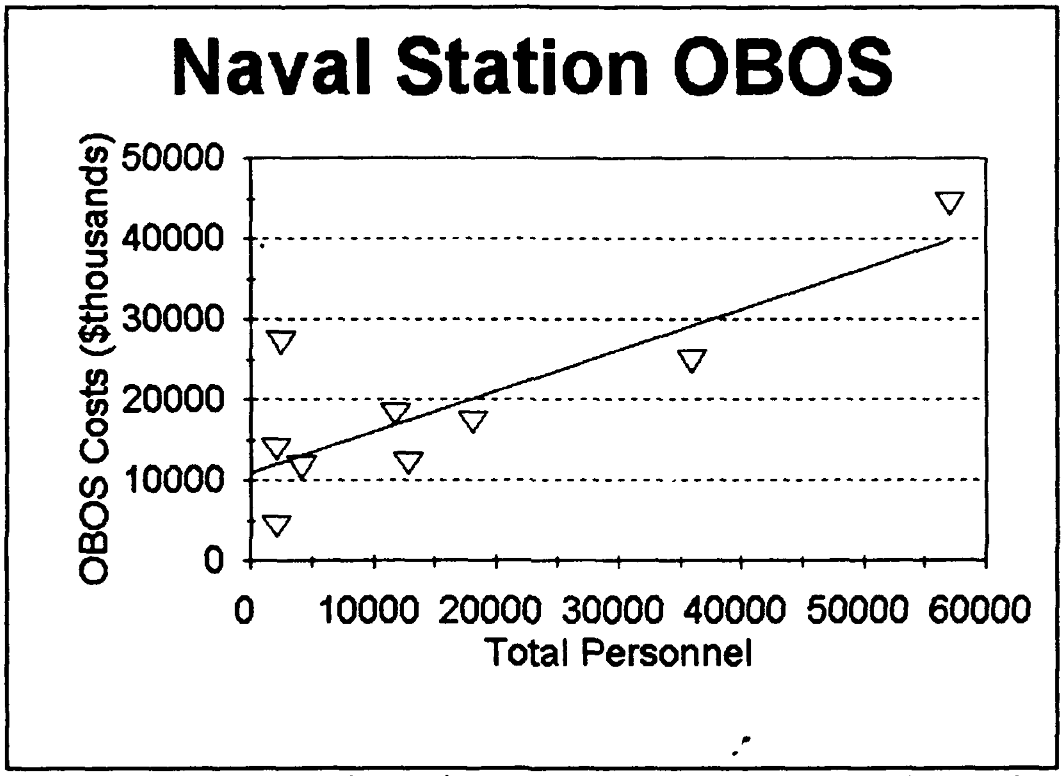

Figure 16 Relationship Between OBOS Costs and Total Personnel for Naval Stations

An exponential model for OBOS costs was also explored. Linear regression of the log transform of the OBOS costs using the log transform of total personnel as the predictor variable gives the following regression equation:

$$\ln OBOS(\$thousands) = 6.74 + 0.327 * \ln TotalPersonnel$$

The adjusted R-squared is 31.2 percent; smaller than for the linear model. The t-statistics for the intercept and slope

coefficients are 4.85 and 2.15, indicating the intercept term is more significant in the log-log model. Note that if this model were used to describe OBOS costs, the coefficient of the ln Total Personnel term (0.327) would indicate that significant economies of scale (with regard to OBOS costs as a function of total personnel) exist for naval stations.

To summarize, it appears that the relationships between MRP costs and building square footage and between OBOS costs and total personnel vary significantly between categories of installations. Direct comparison of the overhead cost models for air stations and naval shipyards illustrates this point. Non-payroll costs for air stations are an exponential function of total personnel. The exponent of the total personnel term is 0.427, indicating that for every 10 percent increase in base population, OBOS costs would be expected to increase 4.27 percent. Non-payroll OBOS costs are an exponential function of base population for naval shipyards also, but the exponent of the total personnel term is 0.949, indicating that OBOS costs rise 9.49 percent for every 10 percent increase in base population. It would seen much greater economies of scale (with regard to OBOS costs) are achieved at air stations.

As noted earlier, the COBRA model does not account for variations in overhead cost relationships between categories of installations when calculating the overhead savings from base closures. This may lead to significant errors when

calculating the overhead savings from a base closure. To illustrate this point consider the closing of an air station that relocates some 6000 personnel to a single receiving air station with a current population of 12000 and non-payroll OBOS costs of $20 million. Using the COBRA equation for OBOS costs (BOS Index = 0.81), the predicted OBOS costs at the receiving base would be:

$$\$20million*(\frac{18000}{12000})**(.81)=\$27.8million$$

If the regression model developed specifically for air stations is used (BOS Index = 0.427), the predicted OBOS costs are:

$$\$20million*(\frac{18000}{12000})**(.427)=\$23.8million$$

The difference in predicted OBOS costs is $4 million per year or approximately 17 percent of the annual OBOS costs. In this case, using the COBRA model will underestimate overhead savings because the OBOS costs at the receiving base are overestimated. Conversely, the COBRA model would tend to overestimate overhead savings for those categories of installations that do not experience significant economies of scale (BOS Index >.81).

Furthermore, the strength of the correlation between square footage and MRP costs and between base population and OBOS costs varies considerably between categories. The

adjusted R-squared for the regression model for MRP costs at naval hospitals is 82.9 percent, indicating a strong relationship between facilities square footage and MRP costs. However, the adjusted R-squared for the MRP cost model at naval shipyards is only 16.7 percent, indicating a very weak or no relationship between square footage and MRP costs. This indicates that other variables, such as the harshness of the climate or the age of the facilities, may influence MRP costs. Future studies may be able to improve the overhead cost models by identifying variables that are better predictors of MRP and OBOS costs.

D. CHOICE OF DISCOUNT RATE

The proper choice of the discount rate is crucial to any net present value analysis like the COBRA model because "...an incorrect discount rate could result in an incorrect investment decision." [Ref. 68] The discount rate must correctly reflect the opportunity cost of the funds invested in the project. Choosing a rate that is higher than the opportunity cost of obtaining funds causes the costs and savings streams in the out-years to be discounted too heavily. For a typical project requiring a large initial investment with savings/benefits spread over subsequent years, the net effect is to underestimate the net present value of the project. Conversely, if the analysis uses a discount rate

that is too low, the net present value of the project will be overstated.

The discount rate used in COBRA is dictated by the policies and guidance of the Office of Management and Budget (OMB) Circular Number A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs." [Ref. 69] Circular A-94 provides guidance on benefit-cost analyses used to evaluate federal programs, including guidance for choosing a discount rate for use in net present value analyses. The guidance must be followed "...in all analyses submitted to OMB in support of legislative and budget programs." [Ref. 70]

Circular A-94 provides guidance on the discount rates to be used in analysis of federal programs based on the type of costs and benefits associated with the program. For programs and public investments that provide benefits and add costs to the general public, the social discount rate is applicable. The social discount rate represents the opportunity cost of the consumption and investment possibilities foregone by society when the public investment is made. A-94 specifies a 7 percent real discount rate[13] in this case because it

[13] Real discount rates have been adjusted to eliminate the effect of expected inflation. According to A-94, real discount rates should be used when analyzing costs and savings that are presented in constant-dollars. The real discount rate can be estimated by subtracting expected inflation from nominal interest rates.

"approximates the marginal pretax rate of return on an average investment in the private sector in recent years." [Ref. 71] OMB identifies another type of federal program or investment that provides benefits or adds costs solely to the federal government or agency. A-94 gives as an example the case of investment in energy-efficient buildings that reduce federal operating costs. These "internal" [Ref. 72] investments do not displace societal consumption and investment; however, they displace other government programs or investments. Therefore, the discount rate should reflect the opportunity cost of government borrowing. A-94 states that "...it is appropriate to calculate such a project's net present value using a comparable-maturity Treasury rate[14] as a discount rate." [Ref. 73]

Circular A-94 recognizes that some federal projects and investments involve both "internal" government cost savings and "external" social benefits and costs. A-94 recommends using the 7 percent social discount rate in these cases, *unless the internal government savings can be analyzed separately from the social benefits.* If the two can be separated, "Federal cost savings and their associated

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[14] The U.S. treasury rate varies daily. According to the Merrill Lynch Bond Indexes, as of October 1, 1993, the Treasury rate for maturities greater than 10 years had ranged from 6.02 to 7.73% over the previous 52 weeks. Note that these are nominal rates.

investment costs may be discounted at the Treasury rate, while the external social benefits and their associated investment costs should be discounted at the 7 percent real rate." [Ref. 74]

The base closure process appears to be a federal investment that involves both "internal" government costs and savings and "external" social costs and benefits. The categories of base closure costs described in Chapter II--military construction costs, moving costs, military and civilian salaries savings, etc.--are all "internal" government costs and savings. However, closing bases also has significant costs and benefits for society as a whole. The lost business activity that accompanies base closure is a measurable cost to society. The return of the military land to civilian uses may provide a measurable benefit to society.

The COBRA model uses a 7 percent real discount rate for the net present value analysis of base closures. At first glance, this would appear to be consistent with OMB Circular A-94 guidance which recommends using the social discount rate for investments that produce social benefits and costs that are not separable from the internal government costs and savings. A closer look at the COBRA net present value analysis reveals flaws in this approach.

The COBRA model does not attempt to include societal benefits and costs in its analysis of the base closure process. Indeed, it is the policy of DOD to include only

costs and savings directly traceable to DOD in the model net present value analysis. The latest GAO analysis stated the DOD position: "DOD believes its responsibility is to determine whether its recommendations will result in savings to DOD, without consideration of the effects on other federal agencies." [Ref. 75]

The costs and savings considered in the COBRA model--military construction costs, overhead savings, military salary savings, etc.--are internal to the government (or more specifically DOD). The investment associated with these internal costs and savings represent funds that cannot be used by DOD for other projects. Therefore, the opportunity cost of these funds is the rate at which the federal government can borrow funds for DOD--the Treasury rate. If the COBRA model is limited solely to DOD-specific costs and savings, then the comparable-maturity Treasury rate should be used as the discount rate in the net present value analysis.

The DOD policy of limiting the COBRA analysis to DOD-specific costs and savings appears contrary to the OMB guidance for benefit-cost analyses. Concerning the identification and measurement of benefits and costs, OMB states "Social net benefits, and not the benefits and costs to the Federal Government, should be the basis for evaluating Government programs or policies that have effects on private citizens or other levels of Government." [Ref. 76] Based on this guidance, it may be argued that analysis of the

base closure process should include estimates of the societal costs and benefits--the costs of lost business, the benefits of returning military land to productive civilian uses, etc.

The DOD policy may be prudent since it is difficult to estimate the social costs and benefits of base closures given the time constraints of the Base Realignment and Closure Commission process. The effects of base closings on local unemployment have been roughly estimated using models developed by the Logistics Management Institute and the Office of Economic Adjustment; however, these models do not assign monetary values to the loss of jobs. [Ref. 77] Estimates of the social benefits of returning closed bases to civilian uses depend not only on the market value of the land but also on type of enterprise, public or private, that replaces military operations. Based on experiences with previous closures, future use of closed bases is difficult to predict [Ref. 78].

To summarize, the discount rate used for COBRA net present value analyses should be based on the type (internal or external) of costs and benefits considered in the model. The current version of COBRA uses a 7 percent real discount rate (the social discount rate) for net present value analyses. If external social costs/benefits are considered, then the social discount rate seems most appropriate. However, DOD policy is to include only internal DOD costs and savings in the COBRA analyses. The investment associated with these internal DOD

costs and savings represents funds that cannot be used by DOD for other projects. The opportunity cost of these funds is the government borrowing rate, the Treasury rate. Therefore, as long as COBRA analyses are limited to DOD costs and savings, the Treasury rate would be a more appropriate discount rate for the COBRA model.

E. SUMMARY

In summary, this chapter examined three of the critical aspects of the COBRA model. Military construction costs were compared to the COBRA construction costs estimates for three Navy bases involved in BRAC I, revealing that the COBRA estimates for this limited sample are within the accuracy expected for a parametric cost-estimating technique. The exponential models used by COBRA to predict overhead cost savings were examined and the relationships between MRP costs and building square footage and between OBOS costs and base population were analyzed for several categories of Navy installations. The study concludes that the relationship between overhead costs and predictor variables such as building square footage vary significantly between categories of installations. The differences appear large enough that use of a single equation to describe either OBOS or MRP costs may cause errors in the prediction of overhead savings from base closures. Finally, the discount rate used in the COBRA net present value analysis was evaluated in light of OMB

Circular A-94 guidance, revealing that COBRA incorrectly applies a social discount rate (vice the Treasury rate) to costs and savings that are internal to DOD. The conclusions that flow from these findings and possible areas for further research are presented in the next chapter.

VI. SUMMARY AND CONCLUSIONS

A. INTRODUCTION

This chapter summarizes the findings of the thesis and draws conclusions on the accuracy of the Cost of Base Realignment Actions (COBRA) model. The chapter is divided into six sections, including this Introduction. Section B summarizes the study, reviewing the major points of each of the previous chapters. Section C presents conclusions based on the findings of the study. Military construction cost estimates, methods for calculating overhead savings, and the choice of discount rate are all analyzed. Section D discusses the Navy use of the COBRA model during the 1993 BRAC process. The budgetary implications of base closures are examined in Section E. The final section (F) provides suggestions for further research on the COBRA model and the base closure process.

B. SUMMARY

Chapter I reviewed the changes in the political and fiscal environments that led to formation of the Base Realignment and Closure Commission. The Cost of Base Realignment Actions model was developed to allow the Commission to analyze the financial implications of proposed base closures.

Chapter II described the costs and savings associated with the closure of military bases. It was shown that closing bases requires a large one-time investment, but that the sizable predicted future savings justify this initial investment. Military construction costs make up the largest portion of the one-time costs of base closure. The predicted future savings are made up primarily of savings from the elimination of military and civilian positions and the reduction of overhead expenses.

Chapter III described the cost-benefit analysis approach and calculation methods of the model. The COBRA algorithms for calculating key costs and savings, such as salary savings and military construction costs, were provided. The cost-benefit analysis method used by COBRA--the net present value approach--was also explained. The key output variables of the model were defined: payback period, net present value, and return on investment year.

Chapter IV surveyed the previous studies of the COBRA model performed by the General Accounting Office, the Institute for Defense Analyses, and the Center for Naval Analyses. These studies identified several key issues, including: exclusion of non-DOD costs from the model, the choice of discount rate, and the limitations of the model when used for industrial activities. The recommendations of these studies led to several improvements to the COBRA model, summarized in Table I.

Chapter V presented data and analyses of three critical aspects of the COBRA model: estimating military construction costs, predicting overhead savings, and the choice of discount rate. COBRA cost estimates were compared to the actual military construction costs for three Navy bases for which the closure process is essentially complete. Overhead costs were analyzed for several categories of Navy/Marine Corps bases to determine if the COBRA algorithms correctly estimate overhead savings. Finally, the discount rate used for COBRA net present value analysis was evaluated in light of the guidance provided in OMB Circular A-94.

C. CONCLUSIONS

1. MILITARY CONSTRUCTION COSTS

The COBRA estimates of military construction costs for the sample Navy bases fall within the expected range for parametric cost-estimating techniques. However, the small number of bases in the sample limits the conclusions that can be drawn regarding the accuracy of the model. Furthermore, the lack of detailed COBRA estimates for BRAC-I hindered the analysis of specific construction projects. Future studies may be able to make more detailed comparisons between COBRA estimates and actual MILCON costs, since the Navy BSAT maintains detailed COBRA construction estimates for the bases involved in the 1991 and 1993 BRAC rounds.

The COBRA estimates of military construction costs are highly dependent on the definition of the base closure scenario. The COBRA model does not estimate the square footage of facilities that will be required at a receiving base; the analysts who are developing the scenario-specific data must estimate the construction requirements outside the model. COBRA produces cost estimates for these construction requirements using standard factors determined from historical construction cost data. The key variables, building or facility type and square footage, are entered in the model as part of the scenario-specific data. Thus, COBRA estimates of construction costs can only be as accurate as the construction requirements defined in the scenario.

Modification of the model to allow entering known construction costs should improve the COBRA net present value analyses. Detailed estimates of construction costs are normally more accurate than parametric cost estimates.

2. OVERHEAD SAVINGS

COBRA mathematical models for non-payroll overhead costs may not adequately describe overhead costs for all types of Navy and Marine Corps installations. Regression analyses of overhead costs for five categories of Navy installations reveals that the relationships between MRP costs and building square footage and between OBOS costs and total personnel vary significantly between categories of installations. Indeed,

for one category--naval shipyards--building square footage and total personnel are weak predictors of non-payroll overhead costs.

COBRA applies the same exponential cost models to all types of bases when estimating overhead savings from base closures, and this may produce significant errors. As shown earlier, if the overhead costs for the receiving bases involved in a particular closure scenario do not behave according to this single model, then the overhead costs may be under- or overestimated by significant amounts. For air stations, which exhibit large economies of scale (as evidenced by exponent terms that are much less than one), applying the current COBRA overhead cost model overestimates the increase in overhead costs at receiving bases. Thus, recurring overhead savings are underestimated. For hospitals, which exhibit economies of scale to a much smaller degree (as evidenced by exponents slightly less than one), applying the COBRA overhead cost model underestimates the increase in overhead costs at receiving facilities. In these cases, recurring overhead savings are overestimated.

Modifying the COBRA overhead cost models to account for the differences in overhead cost relationships across categories of installations may reduce the errors in overhead savings estimates. The regression models for overhead costs presented in this study may be considered rough first attempts to describe the overhead cost relationships for five types of

installations. Regression analyses were limited to single predictor variables (building square footage for MRP costs and total personnel for OBOS costs) and two possible functional forms (linear or logarithmic). Future studies may provide better cost models based on examination of other functional forms and predictor variables.

3. CHOICE OF DISCOUNT RATE

Based on careful reading of OMB Circular A-94, the U.S. Treasury rate appears to be the most appropriate discount rate for COBRA net present value analyses. Current DOD policy limits the COBRA model to internal DOD costs and savings; costs and savings to other government agencies or society as a whole are excluded. According to A-94, costs and savings which are internal to the government (or agency) should be discounted using the government Treasury borrowing rate.

Using the Treasury rate vice the 7 percent real rate to discount the costs and savings in the COBRA net present value analysis would have significant consequences. Published Treasury rates are nominal rates, and must be converted to real rates (modified for the effects of inflation) if constant dollars are to be used in the net present value analyses. Circular A-94 specifies a real interest rate on 30-year Treasury Bonds of 3.8 percent, significantly lower than 7 percent [Ref. 79]. Using the 3.8 percent discount rate will increase the net present values of all base closure

scenarios, since the recurring savings which occur in out-years will be discounted at a lower rate. For example, using the 3.8 percent rate increases the 20-year NPV of the closure of Cecil Field from $200 to $357 million.[15]

Using the Treasury rate to discount costs and savings will also affect the comparison of competing base closure scenarios. One may consider the case where two base closure alternatives are being evaluated to determine the scenario that will produce the greatest savings. The timing and dollar value of the costs and savings streams may be different for the two alternatives, e.g., one alternative may have higher costs early in the project life, with higher expected savings in the later years of the project. Lowering the discount rate (to more closely approximate the true cost of government borrowing) will increase the value of the savings streams in the out-years. The base closure scenario with a larger portion of its savings occuring in the out-years will become relatively more attractive.

D. NAVY USE OF COBRA

Normally there are two types of decisions associated with benefit-cost analysis or capital budgeting--screening decisions and preference decisions [Ref. 80].

[15] The net present values were obtained by performing COBRA analyses for the closure of Cecil Field using different discount rates: 7 percent and 3.8 percent.

Screening involves making decisions based solely on whether a proposed project (such as a base closure) meets some preset standard of acceptance. Preference decisions, on the other hand, are based on the selection of the best course of action from among several alternatives. In the context of the base closure process, the financial screening decision verifies that a particular base closure scenario has a positive net present value, i.e., pays for itself in savings. Preference decisions are required when several closure scenarios meet this screening criterion and the Commission must choose from among them the best closure alternative.

The Navy Base Structure Analysis Team (BSAT), which performs the analyses supporting Navy recommendations for base closures, has used the COBRA model primarily as a screening tool. During the 1991 and 1993 BRAC, the Navy based its recommendations to close particular bases primarily on the need to reduce excess capacity while retaining the highest military value. Once the bases to be closed were identified based on these criteria, COBRA analyses were performed to verify that the decision paid off financially, i.e., had a positive net present value. According to the BSAT Leader for Return on Investment and Economic Impact Analysis, "The primary use of COBRA was to ensure that a closure recommendation made business sense in terms of return on investment. The key decision criteria were always reducing excess capacity and retaining military value." [Ref. 81]

However, COBRA also has been used as a preference decision-making tool. During the 1993 BRAC, the Navy recognized that excess naval aviation depot capacity existed and determined that three of their six depots should be closed. The Navy submitted an initial recommendation to close Naval Aviation Depots in Pensacola, Alameda, and Cherry Point, and verified that the closures did in fact have positive net present values. However, the Navy analysis of operational air stations brought forth the recommendation to close Cecil Field, which would move significant Navy/Marine Corps aviation assets to Cherry Point. Realizing that it may then be desirable to operate the aviation depot at Cherry Point, the Navy conducted a second COBRA analysis for a scenario closing aviation depots at Pensacola, Alameda, and Norfolk. This scenario provided greater savings than the original recommendation and so the recommendation was changed to close the Norfolk depot vice the Cherry Point depot [Ref. 82]. Later, during the deliberations of the Commission, the Navy was called upon to produce COBRA analyses for all possible scenarios for closing three aviation depots. After evaluating the results of the Navy analyses, the Commission approved the Navy recommendation to close aviation depots at Pensacola, Alameda, and Norfolk. [Ref. 83]

Preference decisions are normally more difficult than screening decisions because they call for choosing the best base closure scenario (the one with highest net present value)

from among several alternatives. The evaluation of all the alternative scenarios for closing three aviation depots described above involved considerable effort on the part of the Navy BSAT [Ref. 84]. As DOD budgets decline (in real terms) and the pressure to save defense dollars by closing bases continues, the Navy can be expected to evaluate more closure scenarios from a financial preference perspective.

When base closure alternatives are compared in order to determine the scenario that produces the largest savings, accurate estimation of costs and savings becomes even more critical. If the alternatives have similar net present values, then relatively small errors in the calculation of costs and savings may make an inferior scenario appear more financially attractive than the superior scenario, leading to an incorrect decision. Incorrect decisions would waste precious DOD dollars and expose the Navy and DOD to criticism regarding the base closure selection process. Thus it would seem that the accuracy of the COBRA cost-benefit analysis is critical to the base closure selection process.

This thesis identifies several changes that may be made to improve the accuracy of the COBRA model. Careful definition of the construction requirements for each base closure scenario is the key to producing accurate estimates of military construction costs. Modifying the COBRA overhead cost models for the differences between types of installations

will allow the model to produce better estimates of recurring overhead savings. Finally, changing the discount rate used in COBRA to more accurately reflect the government cost of borrowing funds will produce a more accurate picture of the net present value of base closure alternatives.

E. BUDGETARY IMPLICATIONS OF BRAC-III DECISIONS

Implementation of the decisions resulting from the 1993 BRAC places considerable pressure on an increasingly lean Navy budget. As a result of 1993 Commission decisions, the Navy will close 12 operational bases, 8 major industrial activities, 4 major technical centers, 5 major personnel support activities, and 55 reserve centers. The one-time cost required to close these bases is estimated at $4.1 billion (in fiscal year 1994 dollars), excluding environmental cleanup costs [Ref. 85]. By comparison, the net one-time closure cost for the Navy bases chosen for closure in two earlier rounds is estimated at approximately $800 million [Ref. 86].

Congress appropriates funds annually to the BRAC accounts to pay for these closure costs, but experience with earlier BRAC rounds indicates that the military departments initial estimates of closure costs have been low. As a result, according to GAO, "Congress may have to appropriate more money to the BRAC accounts than previously estimated." [Ref. 87] One of the key reasons for this is the

increase in environmental cleanup costs. Estimates of environmental cleanup costs have increased significantly as detailed studies and tests have been conducted. During the period from fiscal year 1991 to 1993, DOD estimates of environmental cleanup costs for BRAC-I rose from $510 to $859 million, an increase of 66 percent [Ref. 88].

As noted earlier, environmental cleanup costs are excluded from the COBRA model since the DOD is required to clean up bases whether or not they are being closed. Indeed, according to GAO, environmental restoration costs were not "...a factor in the DOD base closure decision-making process..." [Ref. 89]. If estimates of environmental cleanup costs continue to increase dramatically as they have for the first two BRAC rounds, the initial estimates of the funds required in the BRAC accounts obviously will be low. (A 66 percent increase in environmental cleanup costs for the 1993 BRAC would represent a budget shortfall of approximately $500 million.[16]) If the environmental costs turn out to be substantially higher than initial estimates, DOD may be unable to complete the 1993 base closures without appropriation or reallocation of significant additional funds to the BRAC accounts.

[16] Based on the initial DOD estimate of $725 million to clean up the bases on the 1993 base closure list. Note that DOD estimates of the cleanup costs for the 1991 round are already $2 billion.

F. AREAS FOR FURTHER RESEARCH

Analysis of the COBRA model suggests the following issues and research tasks are worthy of further attention:

- Conduct a detailed study of the overhead cost structure at Naval installations. Identify the variables that are the best predictors of Maintenance of Real Property (MRP) and Other Base Operating Support (OBOS) costs. Results may be used to update the COBRA algorithms to more accurately predict overhead savings from base closures.

- Assess the base closure decision process from the social welfare perspective. What social costs and benefits (not included in the COBRA model) might be considered for inclusion in the analysis of proposed base closures?

- Estimate the magnitude of the environmental cleanup problem for military installations selected for closure. Will the cost of cleanup continue to rise as it has during the early rounds of closures?

- Analyze the specific application of the COBRA model to industrial activities such as shipyards, aviation depots, and other repair facilities. Does COBRA allow for the analysis of all relevant costs and savings? Should the model be revised to better accommodate these types of installations?

- Verify the COBRA standard factors by comparing them with the results of past base closures. For example, can key variables such as the percentage of civilians who refuse to relocate during base closure be predicted accurately?

APPENDIX A

A. BRAC-I MILCON COST DATA

Military construction costs for the NS Brooklyn, NS Sand Point, and NS Hunters Point base closures are presented in Table IV. The source of the data is the Department of the Navy FY 1994 Budget justification presented to Congress in April 1993. The military construction costs were converted to FY 1989 dollars using the Price Inflation Indices for Construction prescribed in the Navy Comptroller's guidance for Navy budget preparation. [Ref. 90]

Table IV MILCON Costs in FY 1989 Dollars (thousands)

Base	FY 90	FY 91	FY 92	FY 93	Total
Brook-lyn	19808	12114	0	9283	41205
Sand Point	0	27343	0	50742	78085
Hunter Point	54904	5070	6636	4454	71164

Table V presents the COBRA estimates for the MILCON costs for these base closures. The source of the data is the 1988 Commission estimates of implementation costs as presented by

the Deputy Assistant Secretary of Defense (Installations) to the Military Installations and Facilities Subcommittee of the House Armed Services Committee. [Ref. 91] The raw data are presented in then-year dollars based on the COBRA model assumption of three percent annual inflation. The data in Table II have been converted to FY 1989 dollars taking into account this three percent inflation rate. All comparisons of MILCON costs and estimates presented in this study use constant FY 1989 dollars.

Table V COBRA Estimates of MILCON Costs in FY 1989 Dollars (thousands)

Base	FY 90	FY 91	Beyond	Total
Brooklyn	6796	3770	25766	36333
Sand Point	16505	7541	55086	79132
Hunters Point	40777	39589	0	80366

B. NAVY MILCON STANDARD FACTORS

Table VI presents the Navy's standard factors for military construction as used in the 1988 and the 1993 COBRA model. The source of the for the 1988 data is the original documentation for the COBRA model provided by LMI. The 1993

standard factors are taken from the Navy COBRA standard factor data call. [Ref. 92]

Table VI Navy COBRA Standard Factors for MILCON

Category	Units	1989 Cost factor ($/unit)	1993 Cost Factor ($/unit)
Runways	SY	47	46
Berthing	FB	9968	9859
Air Maint.	SF	114	112
Operations	SF	121	120
Admin.	SF	106	105
Training	SF	112	110
Maint.	SF	95	94
Bachelor Qtrs.	SF	72	79
Family Housing	Unit	79000	61900
Supply	SF	85	84
Dining	SF	157	152
Personnel Support	SF	107	106
Comm ica- tion	SF	173	171
Ship Maint.	SF	109	108
RDT&E	SF	147	145
Ammo Storage	SF	163	161
Medical	SF	158	156

APPENDIX B

OVERHEAD COST DATA

The overhead cost data presented here were obtained during the Navy Base Structure Analysis Team (BSAT) Data Call Number Thirty-seven of September 1992. Data Call Thirty-seven assembled MRP and OBOS cost data from over 200 Navy and Marine Corps installations in the U.S. and its territiories. The Navy BSAT used these data to estimate the RPMA Building Index and BOS Index for Navy facilities. The Indexes were entered as standard factors in the 1993 COBRA model.

This study used these data to develop overhead cost models for several categories of Navy installations: air stations, hospitals, naval stations, communication sites, and naval shipyards.

UIC	Total SF	MRP nonpayroll	OBOS nonpayroll	NAVY civilian	NAVY enlisted	NAVY officer	USMC civilian	USMC enlisted	USMC officer	Total personnel	MRP payroll	OBOS payroll	Family housing	Other	Total cost ($M)
00014	0	0	3323	451	1	37	0	0	0	489	0	0	13	0	3336
00034	0	0	32	0	58	15	0	0	0	73	0	0	0	0	32
00065	20098	316	6878	47	2	21	0	0	0	70	0	824	0	0	8018
00101	647443	51	146	202	51	14	0	66	3	336	0	0	2413	0	2686
00102	3346573	21618	20045	6358	131	68	0	0	0	6557	233	35791	1845	0	84214
00104	8799929	731	15563	5055	30	86	0	0	0	5171	1656	26123	502	177	45361
00105	73949	0	0	44	48	14	0	0	0	106	0	0	0	0	0
00109	2879080	8203	13576	1826	952	52	0	0	0	2830	3940	16530	810	0	46506
00124	637115	750	2308	260	143	282	0	0	0	685	913	971	86	0	5643
00129	2992091	11837	26871	1241	7034	897	0	0	0	9172	3159	15707	10935	1090	88641
00146	4947655	44886	15733	628	183	69	1397	660	103	3040	4417	39062	16681	200	155672
00158	832804	4623	5489	205	107	21	0	69	2	404	1089	5845	1642	160	27001
00161	4074840	29822	16557	1869	4934	432	0	0	0	7235	8929	14637	3718	445	75380
00162	123044	541	436	36	93	33	0	0	0	162	0	249	491	0	2451
00163	874645	3518	11821	3208	30	12	0	0	0	3250	1773	29238	83	0	46433
00164	5381073	7305	21518	3752	57	16	0	0	0	3825	85	27268	337	0	57937
00166	629668	1865	4837	135	128	12	0	0	0	275	733	3174	0	74	19271
00167	2160366	7582	34403	2440	6	19	0	0	0	2465	4245	18159	5	0	67872
00168	4133118	16705	23852	1679	1831	1340	0	0	0	4850	0	12569	325	0	67502
00171	3923729	13206	23415	3250	761	208	0	0	0	4219	6730	24374	4734	2222	85896
00173	3328040	13310	53104	3500	65	59	0	0	0	3624	0	37489	13	0	104291
00174	2543800	11296	20168	2984	412	67	0	0	0	3463	3561	19143	2167	0	57779
00178	1781806	8131	56246	99	420	121	0	0	0	640	2908	18307	1975	0	91091
0017A	276	0	0	40	74	20	0	0	0	134	0	0	397	0	397
00181	7668651	26671	79704	11292	520	97	0	0	0	11909	236	54170	525	5650	170267
00183	1273156	2803	9128	1354	1664	652	0	0	0	3670	612	8256	1364	0	32883
00187	571280	1451	9681	2579	0	14	0	0	0	2593	0	13039	11	4911	29093
00188	4219750	16497	23920	1889	6424	1023	0	72	8	9416	327	9181	5352	154	70962
00189	7950009	1019	7362	3766	109	68	0	0	0	3943	3245	9222	52	526	21426
00191	3040972	3350	12804	5818	19	47	0	0	0	5884	222	18346	82	8313	44998
00193	1651130	3742	11013	1038	2083	113	0	0	0	3234	786	13484	5119	34	37801
00196	477389	923	2944	145	167	29	0	0	0	341	597	4367	324	122	16917
00197	1597823	4965	10573	2528	18	10	0	0	0	2556	0	11009	153	0	27246
00203	319594	2169	3310	367	437	234	0	0	0	1038	168	1660	1143	0	12246
00204	4213423	11298	21141	1675	4684	1777	0	0	0	8136	208	27404	7326	309	81092
00205	1956366	4721	10110	2026	661	221	33	0	0	2941	372	8498	1843	116	31291
00206	987996	3550	4076	401	122	15	0	0	0	538	1212	6778	1398	153	30256
00207	4407537	15154	24354	1965	4802	853	0	0	0	7620	339	20412	3150	1695	89636
00210	7339757	9067	37121	837	6953	155	0	0	0	7945	70	17229	18887	57	95282

UIC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Other	Total cost ($M)
00211	1087559	3955	5604	376	1541	309	0	0	0	2226	0	2310	3856	0	24491
00213	1835675	6176	12447	528	1905	277	0	0	0	2710	3942	13545	10419	918	65515
00215	985271	2159	4193	244	332	48	0	0	0	624	1479	6657	199	230	28567
00216	4388772	4610	7965	859	482	451	0	0	0	1792	5122	12243	3498	503	40103
00221	8447344	15391	67090	7323	1491	183	4	708	32	9741	1662	42092	4915	0	136516
00228	10397004	775	9617	2953	1424	139	0	0	0	4516	1510	14210	4727	342	31538
00231	260744	785	545	60	144	47	0	0	0	251	88	330	0	0	1748
00232	548708	3724	2212	565	757	304	0	0	0	1626	143	1465	383	0	11966
00236	2884183	4925	12444	7823	9565	719	0	0	0	18107	2642	15947	22393	0	71492
00243	2549569	8908	7461	0	9	8	266	1612	225	2120	1756	6515	1864	100	48653
00244	3112986	855	9191	2371	150	64	0	0	0	2585	1933	21057	25	220	35981
00245	3084514	17984	24776	9837	23844	2254	0	0	0	35935	0	14235	20334	465	97842
00246	6132223	15670	35810	12909	15568	2926	0	0	0	31403	0	21744	11128	174	110331
00247	3796019	10323	16323	248	6099	116	0	0	0	6463	0	6651	2226	0	47104
00251	5145012	13473	57963	11837	6098	458	0	0	0	18393	5128	69977	6656	0	161764
00253	2073132	6863	23035	3310	289	18	0	0	0	3617	322	18095	273	0	49339
00255	1316031	7144	4343	1094	869	104	0	0	0	2067	106	8252	3628	0	30218
00259	2034313	6474	11741	1298	2367	837	0	0	0	4502	61	7571	1669	0	37586
00263	0	13485	5782	0	8	12	491	1851	227	2589	1685	15184	2881	200	67944
00264	4173051	25003	21313	5	59	41	1195	2889	680	4869	8811	26123	8497	230	141976
00267	123619	85	284	36	69	20	0	0	0	125	0	327	224	0	920
00274	348956	0	23	67	20	8	0	8	3	106	0	0	0	0	23
00275	1066235	8800	4981	179	288	36	0	5	2	510	205	6070	2448	264	32677
00276	3461	0	0	0	288	36	0	0	0	324	0	0	0	0	0
00281	2235394	6891	12451	615	2682	332	0	0	0	3629	107	6928	2361	0	37539
00311	3521510	13108	40712	4980	237	65	0	0	0	5282	1446	30362	199	0	86808
00314	1164535	9633	11919	243	5030	520	0	0	0	5793	0	5078	13993	26	47789
00318	3813125	23027	7571	628	393	66	365	407	56	1915	2097	8990	0	150	61575
00334	1718012	12428	20794	821	2534	483	0	0	0	3838	0	9324	12799	121	69833
00383	2180201	793	8109	3109	4	70	0	0	0	3183	1719	14810	77	143	25651
00389	2867223	15580	27185	555	1633	209	0	0	0	2397	1094	13007	7257	1062	123291
00406	1044781	264	2537	686	47	22	0	0	0	755	587	5648	37	342	9415
00421	5744615	23425	38378	3153	2905	550	0	0	0	6608	1443	31495	5819	828	125564
00604	2895405	1106	4006	669	70	25	0	0	0	764	1883	5019	133	170	12317
00612	1880769	529	2611	966	73	28	0	0	0	1067	1177	8385	36	0	12776
00619	790742	5201	7803	665	1019	474	0	0	0	2158	121	6935	3991	0	24511
00620	2775115	10909	20945	1397	6633	977	0	230	39	9276	0	15261	6589	0	69497
00639	5399409	6944	22616	2045	2845	357	0	0	0	5247	391	17259	4618	295	68823
00681	10963303	45261	32160	0	1264	227	1265	2310	232	5298	8233	35581	17061	250	166320

UIC	Total SF	MFP nonpayroll	OBOS nonpayroll	civilian	NAVY enlisted	officer	civilian	USMC enlisted	officer	Total personnel	MFP payroll	OBOS payroll	Family housing	Other	Total cost ($M)
00693	2919291	0	0	1	0	0	0	0	0	1	0	0	0	0	0
00702	162386	692	2019	82	342	18	0	0	0	442	570	849	616	0	6965
00743	73387	132	1542	39	202	10	0	0	0	251	0	911	703	0	4025
00788	207365	316	1502	770	139	30	0	0	0	939	69	1475	23	0	4574
00886	6091052	141	1698	303	166	21	0	0	0	490	772	2856	464	0	7977
00948	753646	1111	2978	74	382	100	0	0	0	556	78	326	1366	0	8265
00950	465927	1227	4267	246	1062	53	0	0	0	1361	0	2588	3050	0	13900
0534A	353212	0	0	0	107	27	0	0	0	134	0	0	0	0	0
0545A	12012	0	0	11	18	14	0	0	0	43	0	0	133	0	133
30315	14128	0	116	0	19	2	0	0	0	21	0	0	0	0	116
30316	6020	0	117	0	8	1	0	0	0	9	0	0	26	0	143
39029	61624	0	0	0	130	11	0	0	0	141	0	0	0	0	0
42237	1181841	12212	36391	422	3534	352	0	0	0	4308	577	13927	2084	1242	82114
44466	793212	0	0	1041	537	40	0	0	0	1618	0	1588	357	0	1945
44699	0	1	63	3	23	2	0	0	0	28	0	0	0	0	64
45534	151904	0	0	41	150	33	0	0	0	224	0	0	211	0	211
45610	188516	100	1410	38	154	10	0	0	0	202	0	0	176	0	1686
45854	136649	465	2364	17	206	34	0	0	0	257	0	0	69	0	2898
57023	49416	0	1570	98	148	272	0	0	0	518	0	0	94	0	1664
57053	161147	186	860	56	191	17	0	0	0	264	0	1369	454	0	2869
57055	11675	0	0	1	0	0	0	0	0	1	0	0	0	0	0
57095	5151	5624	7750	760	2071	810	0	0	0	3641	0	1717	3610	15	24848
57099	40563	0	406	1	198	15	0	0	0	214	0	38	694	0	7681
60002	246377	422	1533	160	410	116	0	0	0	686	150	756	511	0	11299
60028	5371287	9577	11577	246	1065	112	36	0	0	1459	63	8336	7400	15	48855
60036	1025885	3749	10037	837	2614	145	0	0	0	3596	951	9821	3053	0	29310
60042	693133	12421	10544	82	239	34	0	0	0	355	0	2906	1075	0	36365
60050	5159249	28980	15123	628	308	89	759	499	73	2356	5199	21149	5017	220	103203
60087	2471652	6416	8013	989	2207	454	0	0	0	3650	2183	7900	4657	709	47154
60138	3004207	890	842	1	4143	243	0	0	0	4387	924	1610	230	0	4496
60169	1825560	8683	4495	628	60	26	321	313	47	1395	2675	8066	4110	0	42803
60191	2784494	12451	24133	1047	7313	999	0	0	0	9359	459	9733	5772	135	71419
60200	2636327	12377	19482	1026	5711	718	0	192	9	7656	192	11996	2272	287	63925
60201	1673511	3715	18270	329	10520	851	0	0	0	11700	608	11609	11370	342	62807
60241	1021886	1915	4927	2379	654	511	1	0	0	3545	2422	6151	1919	224	23951
60258	2545510	9537	23202	4317	7	33	0	0	0	4357	3752	28661	57	0	65579
60259	3557775	15176	24007	12027	5858	958	0	0	0	18843	0	14043	4653	0	74495
60462	1507095	8285	9949	197	2128	204	0	33	2	2564	1844	5778	4171	0	85618
60478	1106523	3355	13302	676	2584	151	0	0	0	3411	2566	13062	3181	0	39517

														Other	Total cost ($M)
60495	1189892	9127	22998	812	1101	201	0	0	0	2114	785	8505	2325	0	52169
60508	1794476	5030	7237	226	797	350	0	0	0	1373	157	5272	2228	154	28087
60530	4046169	15642	62310	4871	928	203	0	25	19	6046	6268	58367	4503	0	149281
60701	2276536	3154	5939	3521	301	18	0	0	0	3840	2759	26098	329	0	39039
60872	253972	3938	3675	79	318	21	0	0	0	418	0	2309	2408	20	20086
60921	1213692	2602	22777	4916	34	12	0	0	0	4962	1099	7332	4	0	34378
61119	825118	669	3388	362	110	24	0	0	0	496	1159	4468	457	0	10141
61165	1618269	7919	17287	1956	14733	1379	0	0	0	18068	360	14029	17865	2144	68704
61174	1294967	1751	13932	337	1562	133	0	0	0	2032	1562	6918	15062	635	47165
61331	893982	2244	10195	1232	379	50	0	0	0	1661	65	15734	1212	0	31744
61337	492416	724	1505	188	330	97	0	0	0	615	675	1583	336	0	6622
61339	288877	702	2609	1195	15	23	0	0	0	1233	0	3534	61	0	6982
61414	2782109	6423	17980	602	9355	935	0	0	0	10892	268	8473	6663	499	49853
61577	780753	3945	7772	484	1423	218	0	0	0	2125	0	9700	7224	0	43155
61665	340602	660	1762	303	223	100	0	0	0	626	195	745	556	0	4725
61755	1055908	10515	11646	314	3508	258	0	0	0	4060	121	7476	15404	209	55617
61762	202907	0	0	87	74	6	0	0	0	167	0	0	0	0	0
61797	390284	682	2378	49	80	21	0	0	0	150	0	619	16	0	3695
62021	1949564	8769	9032	339	3316	647	9	71	37	4419	95	3916	3085	0	31060
62204	4310032	12596	18096	0	18	2	1789	452	58	2320	3810	20898	2140	100	69364
62269	1374901	4373	30840	5286	307	102	0	0	0	5695	3244	22432	308	0	63961
62271	1146515	4593	6046	1770	250	182	0	0	0	2202	2713	7655	4986	88	30661
62285	183766	3032	13611	404	27	28	0	0	0	459	0	726	6	0	17375
62306	301677	50	2607	922	31	20	0	0	0	973	0	3337	0	0	5994
62328	8863	0	0	0	33	19	0	0	0	52	0	0	291	0	291
62367	18297	0	0	51	0	1	0	0	0	52	0	0	2	0	2
62376	625534	2912	4302	694	0	8	0	0	0	702	1533	4788	11	230	14157
62395	397610	3636	6314	1470	0	25	0	0	0	1495	0	9829	83	4206	24068
62424	3200	0	0	6	103	8	0	0	0	117	0	0	0	0	0
62474	301138	0	245	623	0	8	0	0	0	631	0	0	0	0	245
62477	174720	0	239	472	0	32	0	0	0	504	0	0	0	0	239
62494	1117815	846	4074	0	1	2	0	0	0	3	0	0	0	0	5138
62573	1827871	1	3657	0	69	30	110	249	34	492	0	3870	1729	0	21349
62583	4203896	7244	16513	1582	3673	271	0	0	0	5526	5624	28240	8442	790	76725
62586	389358	1870	10538	972	153	14	0	0	0	1139	0	18773	789	96	38241
62603	155889	218	569	8	164	23	0	0	0	195	0	280	27	0	1094
62604	3188481	3638	4883	528	3129	158	0	0	0	3815	1265	10169	814	523	26281
62661	2677164	8829	13229	842	2253	481	0	0	0	3576	1795	12858	9713	717	53280
62670	0	8	191	246	2	14	0	0	0	262	0	0	18	0	217

62673	0	29	110	211	11	5	0	0	0	227	0	0	11	0	150
62678	0	134	194	500	7	16	0	0	0	523	0	0	21	0	349
62681	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62688	2855073	18157	44400	2518	50938	3672	0	0	0	57128	308	12546	26234	1091	127738
62701	66325	0	16	0	17	2	0	0	0	19	0	0	0	0	16
62741	247185	472	841	53	52	59	0	0	0	164	235	1182	521	13	4372
62755	636909	1002	9454	1296	0	13	0	0	0	1309	0	10411	66	4780	25713
62786	0	0	18	304	12	13	0	0	0	329	0	0	48	0	66
62789	64400	0	0	401	7	29	0	0	0	437	0	0	67	0	67
62791	36472	83	408	609	7	19	0	0	0	635	0	0	20	0	511
62793	441979	0	51	537	3464	392	0	0	0	4393	0	0	2674	0	2725
62794	0	0	605	96	2	5	0	0	0	103	0	0	80	0	685
62795	224717	231	919	445	40	30	0	0	0	515	0	0	0	0	1150
62798	0	83	527	152	11	6	0	0	0	169	0	0	0	0	610
62799	0	4	239	125	3	8	0	0	0	136	0	0	43	0	286
62813	3228488	16839	12182	4258	7678	896	0	0	0	12832	136	26044	31036	819	111876
62841	985	3860	3647	61	112	15	0	0	0	188	0	0	0	0	7507
62892	0	0	0	8	0	0	0	0	0	8	0	0	0	0	0
62913	625	0	305	8	21	12	0	0	0	41	0	0	0	0	305
62974	1972375	10645	8654	0	96	25	344	598	53	1116	2666	9875	3225	0	59503
62986	0	0	0	0	625	42	0	0	0	667	0	0	1270	0	1270
62990	15520	15	101	51	3	2	0	0	0	56	0	0	0	0	116
63028	743307	3018	7709	340	176	16	0	0	0	532	0	0	228	0	10955
63038	155861	819	1544	138	119	8	0	0	0	265	940	1637	419	0	8061
63042	2427989	9084	11909	1377	3862	468	0	0	0	5707	2682	17443	13000	120	71796
63043	1254670	4652	6539	299	756	253	0	0	0	1308	34	5949	2004	543	28207
63082	1101523	3396	9190	214	712	51	0	0	0	977	0	2785	3220	0	25038
63117	11819	0	0	12	17	20	0	0	0	49	0	0	26	0	26
63124	0	37	230	338	25	15	0	0	0	378	0	0	36	0	303
63126	3670603	25621	62382	5074	1713	277	0	0	0	7064	279	34889	7610	618	135317
63138	46164	334	995	145	77	28	0	0	0	250	0	0	244	0	1573
63238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63322	180540	201	879	22	319	25	0	0	0	366	39	537	33	0	1689
63387	679940	941	4524	2186	1	13	0	0	0	2200	0	11976	10	2715	20166
63394	685962	4209	18981	2234	102	20	0	0	0	2356	890	13264	335	0	38124
63401	169721	460	995	10	20	3	0	0	0	33	0	219	16	0	1690
63402	845723	2075	3191	308	98	18	0	0	0	424	0	0	124	0	5390
63406	814711	7238	9791	95	4825	341	0	0	0	5261	53	3532	3389	0	31765
63410	56728	0	650	82	82	11	0	0	0	175	0	0	79	0	729

UIC	Total SF	MRP nondevol	OBOS nondevol	NAVY civilian	NAVY enlisted	NAVY officer	USMC civilian	USMC enlisted	USMC officer	personnel	MRP devol	OBOS devol	Family housing	Other	Total cost ($M)
63420	0	0	0	1519	95	78	0	0	0	1692	0	0	21	0	21
63425	8496	20	202	14	61	3	0	0	0	78	72	144	218	0	656
63886	283894	2857	3776	20	584	19	0	0	0	623	136	771	2597	0	16896
63891	278873	1961	2823	147	907	72	0	0	0	1126	313	1867	1286	0	10352
64281	243464	52	5273	923	0	5	0	0	0	928	48	5008	0	0	10601
64356	201623	1986	1265	76	33	6	0	0	0	115	117	953	73	117	6685
65113	291821	0	3123	619	0	13	0	0	0	632	368	3645	69	310	7515
65114	258693	215	3170	775	0	9	0	0	0	784	0	6246	19	1462	11112
65198	27035	0	554	8	52	9	0	0	0	69	0	309	0	0	863
65236	22500	837	5348	315	0	4	0	0	0	319	0	2598	3	0	8786
65492	258737	780	1847	291	526	181	0	0	0	998	160	1356	713	0	10642
65540	850637	5591	16546	1666	31	9	0	0	0	1706	0	9505	0	0	32012
65870	77	0	0	129	14	4	0	0	0	147	0	0	29	0	29
65885	2433782	3827	18851	3132	19	13	0	0	0	3164	448	12787	155	0	38055
65886	1815235	1460	14930	2500	16	15	0	0	0	2531	32	19144	18	0	36979
65887	2410098	11226	30189	4022	17	14	0	0	0	4053	6013	19199	31	0	68614
65888	2817448	6457	9307	3524	18	14	0	0	0	3556	1615	15464	25	0	34950
65889	1766224	3845	19397	3495	25	17	0	0	2	3539	0	14692	75	0	39091
65908	0	0	0	0	1	0	0	0	0	1	0	0	8	0	8
65913	112109	0	0	569	44	4	0	0	0	617	0	0	40	0	40
65923	1453640	4747	15929	2925	74	19	0	0	0	3018	0	13967	0	0	37654
65928	4556318	7418	15841	606	6898	284	0	0	0	7788	2542	12083	3895	197	51808
65980	537468	1944	4972	358	47	5	0	0	0	410	0	2699	59	0	9674
66001	1755301	12305	57444	4043	354	122	0	0	0	4519	0	41906	202	0	113269
66023	15400	97	196	20	34	14	0	0	0	68	0	111	86	0	1429
66094	119873	277	397	109	183	76	0	0	0	368	247	377	0	0	2798
66604	2059047	5814	39504	3686	67	33	0	0	0	3786	2825	22560	101	0	71577
66754	156568	1363	1466	94	299	18	0	0	0	411	439	1537	1274	0	8871
66863	58628	0	593	37	24	5	0	0	0	66	50	72	19	0	734
66898	226059	0	0	33	59	19	0	0	0	111	0	0	102	0	102
67001	12492674	70492	44201	0	1554	214	1565	2445	223	6001	14101	30553	15917	270	219583
67004	5306604	11484	19268	0	4	3	2547	818	137	3509	3719	15082	2544	200	67019
67011	143469	335	634	0	18	18	1604	2486	240	4366	183	74	0	0	1561
67029	285408	919	1077	0	1	1	47	953	52	1054	264	531	223	0	3544
67353	460185	1312	6048	0	1	2	40	220	26	289	394	917	0	15040	33346
67385	726163	4663	2236	0	10	10	46	109	87	262	94	761	0	0	17827
67391	200619	1002	2294	0	3	2	5	0	0	10	46	235	0	0	3577
67399	3579384	13089	21579	0	359	54	523	1163	138	2237	5207	10416	12570	161	89267
67443	83972	0	41	0	0	0	388	169	35	592	0	0	826	0	867

UIC	[illegible] SF	[illegible]	[illegible]	NAVY			USMC			[illegible]	[illegible]	[illegible]	[illegible]	Other	Total cost ($M)
				civilian	enlisted	officer	civilian	enlisted	officer			payroll	housing		
67604	392066	0	0	0	0	0	0	86	8	94	0	0	0	0	0
67862	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68084	438978	0	0	411	531	252	0	0	0	1194	0	0	775	0	775
68086	325848	876	1934	161	287	117	0	0	0	565	0	1159	0	0	6311
68093	491973	320	1804	394	569	209	0	0	0	1172	386	2140	0	0	7889
68094	487563	2900	2855	429	574	279	0	0	0	1282	0	2544	0	0	13275
68095	287666	1037	2664	389	337	162	0	0	0	888	0	1700	459	0	9294
68096	375012	5870	3588	129	279	136	0	0	0	544	0	1284	2408	0	13150
68098	216190	218	148	142	256	79	0	0	0	477	0	651	1194	0	3540
68297	1141019	5768	12843	221	488	47	0	0	0	756	0	4033	663	34	36037
68305	220541	605	4877	373	10	6	0	0	0	389	350	3467	35	635	10401
68317	152666	42	967	32	74	21	0	0	0	127	0	427	7	16	1775
68322	550251	2154	3941	2773	713	89	0	0	0	3575	0	5482	594	0	14657
68335	2488144	12251	28123	2441	308	65	0	0	0	2814	2077	15377	2699	67	65947
68373	17167	4	97	9	8	16	0	0	0	33	0	0	133	0	234
68378	762380	1708	14784	1725	0	8	0	0	0	1733	0	13057	39	4779	34367
68436	1062995	5891	21676	659	3021	355	0	0	0	4035	990	12449	3297	143	51620
68437	324500	592	1979	54	397	46	0	0	0	497	0	985	521	0	4077
68438	585931	2502	5924	1100	759	50	0	0	0	1909	0	3570	905	519	13864
68462	185277	0	6751	503	0	13	0	0	0	516	0	4664	0	0	11415
68660	119	173	485	45	141	9	0	0	0	195	194	1746	112	0	3013
68701	521000	678	2639	270	428	47	0	0	0	745	0	1066	281	0	4664
68709	0	0	22	98	1573	329	0	0	0	2000	0	0	0	0	22
68711	97536	0	491	567	2	20	0	0	0	589	0	0	10	0	501
68733	978417	2502	4361	0	97	18	0	0	0	115	0	0	62	0	6925
68734	0	77	315	36	147	9	0	0	0	192	0	0	73	0	465
68759	0	449	242	0	147	9	0	0	0	156	0	0	699	0	1390
68836	35215	299	2073	456	0	15	0	0	0	471	665	4613	11	342	8003
68889	200210	235	4311	103	501	59	0	0	0	663	135	2825	0	262	8701
68890	104335	863	4902	74	150	31	0	0	0	255	252	3414	0	55	10534
68891	230414	668	10707	191	901	85	0	0	0	1177	275	3428	158	15	18159
70092	533093	2344	4297	722	450	216	0	0	0	1388	0	4612	28	0	14444
70240	0	0	0	7	332	11	0	0	0	350	0	0	0	0	0
70243	527005	1722	8356	111	1035	40	0	0	0	1186	0	2823	11833	0	30124
70272	380189	795	4002	560	661	31	0	0	0	1252	440	3265	168	0	10853
70273	117203	173	481	57	2	1	0	0	0	60	194	1746	32	0	2626
90691	450683	0	0	0	2	1	0	0	0	3	0	0	0	0	0
90645	1809593	0	0	0	2	1	0	0	0	3	0	0	0	0	0
91041	814576	0	0	0	2	1	0	0	0	3	0	0	0	0	0

[illegible]	[illegible]	[illegible]	[illegible]	[illegible] NAVY [illegible]			[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Total
UIC	[illegible]	[illegible]	[illegible]	civilian	enlisted	officer	civilian	enlisted	officer	personnel	[illegible]	[illegible]	[illegible]	Other	cost ($M)
91192	1426489	0	0	0	2	1	0	0	0	3	0	0	0	0	0
91285	823152	0	0	0	2	1	0	0	0	3	0	0	0	0	0
91741	177462	0	0	0	2	1	0	0	0	3	0	0	0	0	0
91961	4558581	0	0	0	2	1	0	0	0	3	0	0	0	0	0
92782	136237	0	0	0	2	1	0	0	0	3	0	0	0	0	0
93055	1618346	0	0	0	2	1	0	0	0	3	0	0	0	0	0
93880	274733	0	0	0	2	1	0	0	0	3	0	0	0	0	0
94750	547633	0	0	0	2	1	0	0	0	3	0	0	0	0	0
96095	818256	0	0	0	0	6	0	0	0	6	0	0	41	0	41
97214	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0

APPENDIX C

REGRESSION ANALYSES

The detailed results of the regression analyses are provided in this appendix. Regression analyses were conducted using MINITAB statistical software for minicomputers.

The appendix has five sections, one for each of the five categories of installations examined by this study: naval hospitals, communication facilities, naval shipyards, Navy/Marine Corps air stations, and naval stations. Each section contains a table presenting the overhead cost data for the sample group, followed by the MINITAB results for the four regression analyses performed for each sample.

A. NAVAL HOSPITALS

Table VII NON-PAYROLL OVERHEAD FOR NAVAL HOSPITALS

Installa--tion	Total SF	MRP (non-payroll)	Personnel	OBOS (non-payroll)
Bethesda	4133118	16705	4850	23852
Ports-mouth, VA	1273156	2803	3670	9128
Pensacola	319594	2169	1038	3310
Great Lakes	1087559	3955	2226	5604
Jackson-ville	548708	3724	1626	2212
San Diego	2034313	6474	4502	11741
Oakland	790742	5201	2158	7803
Beaufort	492416	724	615	1505
Orlando	258737	780	998	1847
Cherry Point	119873	277	368	397
Newport	325848	876	565	1934
Camp LeJeune	491973	320	1172	1804
Camp Pendleton	487563	2900	1282	2855
Bremerton	287666	1037	888	2664
Guam	375012	5870	544	3588

Regression of MRP vs. Square footage of facilities

The regression equation is
MRP = 368 + 0.00371 Total SF

Predictor	Coef	Stdev	t-ratio	p
Constant	367.9	590.2	0.62	0.544
Total SF	0.0037076	0.0004467	8.30	0.000

s = 1723 R-sq = 84.1% R-sq(adj) = 82.9%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	204462304	204462304	68.90	0.000
Error	13	38580432	2967725		
Total	14	243042736			

Obs.	Total SF	MRP	Fit	Stdev.Fit	Residual	St.Resid
1	4133118	16705	5692	1525	1013	1.26 X
2	1273156	2803	5088	480	-2285	-1.38
3	319594	2169	1553	508	616	0.37
4	1087559	3955	4400	455	-445	-0.27
5	548708	3724	2402	467	1322	0.80
6	2034313	6474	7910	585	-1436	-0.91
7	790742	5201	3300	446	1901	1.14
8	492416	724	2194	475	-1470	-0.89
9	258737	780	1327	522	-547	-0.33
10	119873	277	812	556	-535	-0.33
11	325848	876	1576	507	-700	-0.43
12	491973	320	2192	476	-1872	-1.13
13	487563	2900	2176	476	724	0.44
14	287666	1037	1434	515	-397	-0.24
15	375012	5870	1758	496	4112	2.49R

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

Regression of ln MRP vs. ln Square footage

The regression equation is
ln MRP = - 5.84 + 1.02 ln SF

Predictor	Coef	Stdev	t-ratio	p
Constant	-5.843	3.101	-1.88	0.082
ln SF	1.0155	0.2335	4.35	0.001

s = 0.7790 R-sq = 59.3% R-sq(adj) = 56.1%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	11.476	11.476	18.91	0.001
Error	13	7.888	0.607		
Total	14	19.364			

Obs.	ln SF	ln MRP	Fit	Stdev.Fit	Residual	St.Resid
1	15.2	9.723	9.628	0.505	0.096	0.16 X
2	14.1	7.938	8.432	0.276	-0.493	-0.68
3	12.7	7.682	7.028	0.242	0.654	0.88
4	13.9	8.283	8.272	0.252	0.011	0.01
5	13.2	8.223	7.577	0.201	0.646	0.86
6	14.5	8.776	8.908	0.359	-0.132	-0.19
7	13.6	8.557	7.948	0.215	0.609	0.81
8	13.1	6.585	7.467	0.204	-0.882	-1.17
9	12.5	6.659	6.814	0.272	-0.154	-0.21
10	11.7	5.624	6.032	0.415	-0.408	-0.62
11	12.7	6.775	7.048	0.239	-0.272	-0.37
12	13.1	5.768	7.466	0.204	-1.698	-2.26R
13	13.1	7.972	7.457	0.204	0.515	0.69
14	12.6	6.944	6.921	0.256	0.023	0.03
15	12.8	8.678	7.190	0.223	1.487	1.99

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

Regression of OBOS vs. Total personnel

The regression equation is
OBOS = - 1236 + 3.73 Personel

Predictor	Coef	Stdev	t-ratio	p
Constant	-1236	1133	-1.09	0.295
Personel	3.7277	0.5018	7.43	0.000

s = 2735 R-sq = 80.9% R-sq(adj) = 79.5%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	412692896	412692896	55.19	0.000
Error	13	97214328	7478025		
Total	14	509907232			

Obs.	Personel	OBOS	Fit	Stdev.Fit	Residual	St.Resid
1	4850	23852	16843	1701	7009	3.27R
2	3670	9128	12444	1188	-3316	-1.35
3	1038	3310	2633	795	677	0.26
4	2226	5604	7061	743	-1457	-0.55
5	1626	2212	4825	710	-2613	-0.99
6	4502	11741	15546	1543	-3805	-1.69
7	2158	7803	6808	733	995	0.38
8	615	1505	1056	912	449	0.17
9	998	1847	2484	805	-637	-0.24
10	368	397	135	996	262	0.10
11	565	1934	870	929	1064	0.41
12	1172	1804	3132	767	-1328	-0.51
13	1282	2855	3542	747	-687	-0.26
14	888	2664	2074	832	590	0.23
15	544	3588	791	935	2797	1.09

R denotes an obs. with a large st. resid.

Regression of ln OBOS vs. ln Total personnel

The regression equation is
ln OBOS = 0.16 + 1.11 ln Pers

Predictor	Coef	Stdev	t-ratio	p
Constant	0.160	1.173	0.14	0.893
ln Pers	1.1093	0.1624	6.83	0.000

s = 0.4825 R-sq = 78.2% R-sq(adj) = 76.5%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	10.866	10.866	46.67	0.000
Error	13	3.027	0.233		
Total	14	13.893			

Obs.	ln Pers	ln OBOS	Fit	Stdev.Fit	Residual	St.Resid
1	8.49	10.080	9.574	0.246	0.505	1.22
2	8.21	9.119	9.265	0.208	-0.146	-0.34
3	6.95	8.105	7.864	0.130	0.241	0.52
4	7.71	8.631	8.710	0.151	-0.079	-0.17
5	7.39	7.702	8.362	0.129	-0.660	-1.42
6	8.41	9.371	9.492	0.236	-0.121	-0.29
7	7.68	8.962	8.676	0.148	0.286	0.62
8	6.42	7.317	7.283	0.175	0.033	0.07
9	6.91	7.521	7.821	0.132	-0.299	-0.64
10	5.91	5.984	6.714	0.241	-0.730	-1.75
11	6.34	7.567	7.189	0.185	0.378	0.85
12	7.07	7.498	7.999	0.126	-0.501	-1.08
13	7.16	7.957	8.098	0.125	-0.141	-0.30
14	6.79	7.888	7.691	0.140	0.197	0.43
15	6.30	8.185	7.147	0.190	1.038	2.34R

R denotes an obs. with a large st. resid.

B. COMMUNICATION SITES

Table VIII NON-PAYROLL OVERHEAD FOR COMMUNICATION FACILITIES

Installa-tion	Total SF	MRP (non-payroll)	Personnel	OBOS (non-payroll)
Puerto Rico	73387	132	251	1542
Chelten-ham, Md	207365	316	939	1502
Honolulu	465927	1227	1361	4267
Cutler	155861	819	265	1544
Key West	8496	20	78	202
Guam	527005	1722	1186	8356
Norfolk	380189	795	1252	4002

Regression of MRP Costs vs. Square footage of facilities

The regression equation is
MRP = - 15 + 0.00283 SF

Predictor	Coef	Stdev	t-ratio	p
Constant	-15.2	174.9	-0.09	0.934
SF	0.0028256	0.0005483	5.15	0.004

s = 268.5   R-sq = 84.2%   R-sq(adj) = 81.0%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	1914913	1914913	26.56	0.004
Error	5	360514	72103		
Total	6	2275428			

Obs.	SF	MRP	Fit	Stdev.Fit	Residual	St.Resid
1	73387	132	192	144	-60	-0.27
2	207365	316	571	105	-255	-1.03
3	465927	1227	1301	152	-74	-0.34
4	155861	819	425	116	394	1.63
5	8496	20	9	171	11	0.05
6	527005	1722	1474	178	248	1.24
7	380189	795	1059	121	-264	-1.10

Regression of ln MRP vs ln Square footage

The regression equation is
ln MRP = - 6.47 + 1.04 ln SF

Predictor	Coef	Stdev	t-ratio	p
Constant	-6.471	1.510	-4.29	0.008
ln SF	1.0402	0.1257	8.27	0.000

s = 0.4461 R-sq = 93.2% R-sq(adj) = 91.8%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	13.619	13.619	68.45	0.000
Error	5	0.995	0.199		
Total	6	14.614			

Obs.	ln SF	ln MRP	Fit	Stdev.Fit	Residual	St.Resid
1	11.2	4.883	5.183	0.192	-0.300	-0.74
2	12.2	5.756	6.263	0.173	-0.507	-1.23
3	13.1	7.112	7.105	0.220	0.007	0.02
4	12.0	6.708	5.966	0.169	0.742	1.80
5	9.0	2.996	2.940	0.400	0.056	0.28
6	13.2	7.451	7.233	0.230	0.218	0.57
7	12.8	6.678	6.894	0.204	-0.215	-0.54

Regression of OBOS vs. Total Personnel

The regression equation is
OBOS = 228 + 3.72 Personel

Predictor	Coef	Stdev	t-ratio	p
Constant	228	1399	0.16	0.877
Personel	3.717	1.530	2.43	0.059

s = 2045   R-sq = 54.1%   R-sq(adj) = 44.9%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	24673940	24673940	5.90	0.059
Error	5	20915994	4183199		
Total	6	45589936			

Obs	.Personel	OBOS	Fit	Stdev.Fit	Residual	St.Resid
1	251	1542	1161	1099	381	0.22
2	939	1502	3718	819	-2216	-1.18
3	1361	4267	5287	1199	-1020	-0.62
4	265	1544	1213	1084	331	0.19
5	78	202	518	1301	-316	-0.20
6	1186	8356	4636	1010	3720	2.09R
7	1252	4002	4882	1077	-880	-0.51

Regression of ln OBOS vs. ln Total personnel

The regression equation is
ln OBOS = 1.54 + 0.966 ln Pers

Predictor	Coef	Stdev	t-ratio	p
Constant	1.536	1.384	1.11	0.318
ln Pers	0.9657	0.2186	4.42	0.007

s = 0.5912 R-sq = 79.6% R-sq(adj) = 75.5%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	6.8183	6.8183	19.51	0.007
Error	5	1.7475	0.3495		
Total	6	8.5658			

Obs.	ln Pers	ln OBOS	Fit	Stdev.Fit	Residual	St.Resid
1	5.53	7.341	6.873	0.274	0.468	0.89
2	6.84	7.315	8.147	0.259	-0.832	-1.57
3	7.22	8.359	8.505	0.308	-0.146	-0.29
4	5.58	7.342	6.925	0.267	0.417	0.79
5	4.36	5.308	5.744	0.470	-0.436	-1.21
6	7.08	9.031	8.372	0.288	0.659	1.28
7	7.13	8.295	8.425	0.296	-0.130	-0.25

C. NAVAL SHIPYARDS

Table IX NON-PAYROLL OVERHEAD FOR NAVY SHIPYARDS

Installa-tion	Total SF	MRP (non-payroll)	Personnel	OBOS (non-payroll)
Ports-mouth,NH	3346573	21618	6557	20045
Ports-mouth,VA	7668651	26671	11909	79704
Charles-ton	3040972	3350	5884	12804
Mare Island	8447344	15391	9741	67090
Puget Sound	5145012	13473	18393	57963
Pearl Harbor	3521510	13108	5282	40712
Long Beach	2545510	9537	4357	23202

Regression of MRP vs. Square Footage of Facilities

The regression equation is
MRP = 6125 + 0.00179 SF

Predictor	Coef	Stdev	t-ratio	p
Constant	6125	6377	0.96	0.381
SF	0.001788	0.001205	1.48	0.198

s = 6984 R-sq = 30.6% R-sq(adj) = 16.7%

SOURCE	DF	SS	MS	F	p
Regression	1	107295864	107295864	2.20	0.198
Error	5	243855456	48771092		
Total	6	351151328			

Obs.	SF	MRP	Fit	Stdev.Fit	Residual	St.Resid
1	3346573	21618	12108	3179	9510	1.53
2	7668651	26671	19834	4334	6837	1.25
3	3040972	3350	11561	3398	-8211	-1.35
4	8447344	15391	21226	5111	-5835	-1.23
5	5145012	13473	15323	2669	-1850	-0.29
6	3521510	13108	12420	3067	688	0.11
7	2545510	9537	10676	3803	-1139	-0.19

Regression of ln MRP vs. ln Square footage

The regression equation is
ln MRP = - 2.65 + 0.791 ln SF

Predictor	Coef	Stdev	t-ratio	p
Constant	-2.651	8.228	-0.32	0.760
ln SF	0.7908	0.5379	1.47	0.201

s = 0.6177   R-sq = 30.2%   R-sq(adj) = 16.2%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	0.8247	0.8247	2.16	0.201
Error	5	1.9077	0.3815		
Total	6	2.7323			

Obs.	ln SF	ln MRP	Fit	Stdev.Fit	Residual	St.Resid
1	15.0	9.981	9.230	0.274	0.752	1.36
2	15.9	10.191	9.885	0.382	0.306	0.63
3	14.9	8.117	9.154	0.304	-1.037	-1.93
4	15.9	9.642	9.962	0.425	-0.320	-0.71
5	15.5	9.508	9.570	0.249	-0.061	-0.11
6	15.1	9.481	9.270	0.261	0.211	0.38
7	14.7	9.163	9.013	0.373	0.150	0.30

Regression of OBOS vs. Total Personnel

The regression equation is
OBOS = 12182 + 3.48 Personel

Predictor	Coef	Stdev	t-ratio	p
Constant	12182	17193	0.71	0.510
Personel	3.481	1.720	2.02	0.099

s = 20937 R-sq = 45.0% R-sq(adj) = 34.0%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	1795580928	1795580928	4.10	0.099
Error	5	2191709696	438341952		
Total	6	3987290624			

Obs.	Personel	OBOS	Fit	Stdev.Fit	Residual	St.Resid
1	557	20045	35006	8861	-14961	-0.79
2	11909	79704	53636	9479	26068	1.40
3	5884	12804	32664	9438	-19860	-1.06
4	9741	67090	46090	8052	21000	1.09
5	18393	57963	76207	18183	-18244	-1.76
6	5282	40712	30568	10040	10144	0.55
7	4357	23202	27348	11090	-4146	-0.23

Regression of ln OBOS vs. ln Total Personnel

The regression equation is
ln OBOS = 1.97 + 0.949 ln Pers

Predictor	Coef	Stdev	t-ratio	p
Constant	1.969	3.877	0.51	0.633
ln Pers	0.9491	0.4315	2.20	0.079

s = 0.5397   R-sq = 49.2%   R-sq(adj) = 39.0%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	1.4091	1.4091	4.84	0.079
Error	5	1.4564	0.2913		
Total	6	2.8654			

Obs.	ln Pers	ln OBOS	Fit	Stdev.Fit	Residual	St.Resid
1	8.79	9.906	10.310	0.219	-0.405	-0.82
2	9.39	11.286	10.877	0.271	0.409	0.88
3	8.68	9.458	10.207	0.240	-0.750	-1.55
4	9.18	11.114	10.686	0.223	0.428	0.87
5	9.82	10.968	11.289	0.419	-0.322	-0.94
6	8.57	10.614	10.105	0.267	0.509	1.09
7	8.38	10.052	9.922	0.327	0.130	0.30

D. NAVY/MARINE CORPS AIR STATIONS

Table X NON-PAYROLL OVERHEAD FOR NAVY/MARINE CORPS AIR

Installation	Total SF	MRP (non-payroll)	Personnel	OBOS (non-payroll)
Cherry Point	4947655	44886	3040	15733
Wilming-ton	832804	4623	404	5489
Lemoore	2427989	9084	5707	11909
Meridian	1254670	4652	1308	6539
Yuma	1972375	10645	1116	8654
Fallon	1189892	9127	2114	22998
Whiting	1794476	5030	1373	7237
Guam	780753	3945	2125	7772
El Centro	693133	12421	355	10544
El Toro	5159249	28980	2356	15123
Bruns-wick	2471652	6416	3650	8013
Beaufort	1825560	8683	1395	4495
Oceana	2784494	12451	9359	24133
Cecil Field	2636327	12377	7656	19482
Kings-ville	1021886	1915	3545	4927
Miramar	3557775	15176	18843	24007
Adak	1507095	8285	2564	9949
Key West	1835675	6176	2710	12447
Dallas	985271	2159	624	4193

Table XI NAVY/MARINE CORPS AIR (cont.)

Installa -tion	Total SF	MRP (non-payroll)	Personnel	OBOS (non-payroll)
Corpus Christi	4388772	4610	1792	7965
Alameda	2884183	4925	18107	12444
San Diego	6132223	15670	31403	35810
Glenview	1066235	8800	510	4981
Kanehoe Bay	3813125	23027	1915	7571
Barbers Point	1718012	12428	3838	20794
Whidbey Isld.	2775115	10909	9276	20945
Memphis	5399409	6944	5247	22816
Jackson-ville	4407537	15154	7620	24354
New Orleans	987996	3550	538	4076
Pensa-cola	4213423	11298	8136	21141
Norfolk	4219750	16497	9416	23920

Regression of MRP vs. Square footage of facilities

The regression equation is
MRP = 2424 + 0.00325 SF

Predictor	Coef	Stdev	t-ratio	p
Constant	2424	2516	0.96	0.343
SF	0.0032526	0.0008226	3.95	0.000

s = 7111   R-sq = 35.0%   R-sq(adj) = 32.8%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	790547968	790547968	15.63	0.000
Error	29	1466456960	50567480		
Total	30	2257005056			

Obs.	SF	MRP	Fit	Stdev.Fit	Residual	St.Resid
1	4947655	44886	18517	2291	26369	3.92R
2	832804	4623	5133	1957	-510	-0.07
3	2427989	9084	10322	1288	-1238	-0.18
4	1254670	4652	6505	1709	-1853	-0.27
5	1972375	10645	8840	1389	1805	0.26
6	1189892	9127	6295	1745	2832	0.41
7	1794476	5030	8261	1452	-3231	-0.46
8	780753	3945	4964	1989	-1019	-0.15
9	693133	12421	4679	2045	7742	1.14
10	5159249	28980	19205	2438	9775	1.46
11	2471652	6416	10464	1284	-4048	-0.58
12	1825560	8683	8362	1440	321	0.05
13	2784494	12451	11481	1283	970	0.14
14	2636327	12377	10999	1277	1378	0.20
15	1021886	1915	5748	1842	-3833	-0.56
16	3557775	15176	13996	1486	1180	0.17
17	1507095	8285	7326	1579	959	0.14
18	1835675	6176	8395	1437	-2219	-0.32
19	985271	2159	5629	1864	-3470	-0.51
20	4388772	4610	16699	1927	-12089	-1.77
21	2884183	4925	11805	1294	-6880	-0.98
22	6132223	15670	22370	3148	-6700	-1.05 X
23	1066235	8800	5892	1816	2908	0.42
24	3813125	23027	14827	1603	8200	1.18
25	1718012	12428	8012	1483	4416	0.63
26	2775115	10909	1451	1282	-542	-0.08
27	5399409	6944	9986	2608	-13042	-1.97
28	4407537	15154	16760	1938	-1606	-0.23
29	987996	3550	5638	1862	-2088	-0.30
30	4213423	11298	16129	1821	-4831	-0.70
31	4219750	16497	16149	1825	348	0.05

Regression of ln MRP vs. ln Square footage

The regression equation is
ln MRP = - 0.82 + 0.677 ln SF

Predictor	Coef	Stdev	t-ratio	p
Constant	-0.818	2.307	-0.35	0.725
ln SF	0.6773	0.1579	4.29	0.000

s = 0.5603   R-sq = 38.8%   R-sq(adj) = 36.7%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	5.7722	5.7722	18.39	0.000
Error	29	9.1037	0.3139		
Total	30	14.8758			

Obs.	ln SF	ln MRP	Fit	Stdev.Fit	Residual	St.Resid
1	15.4	10.712	9.622	0.164	1.090	2.04R
2	13.6	8.439	8.415	0.182	0.024	0.05
3	14.7	9.114	9.139	0.102	-0.025	-0.05
4	14.0	8.445	8.692	0.133	-0.247	-0.45
5	14.5	9.273	8.999	0.102	0.274	0.50
6	14.0	9.119	8.656	0.139	0.463	0.85
7	14.4	8.523	8.935	0.105	-0.411	-0.75
8	13.6	8.280	8.371	0.191	-0.091	-0.17
9	13.4	9.427	8.290	0.207	1.137	2.18R
10	15.5	10.274	9.650	0.169	0.624	1.17
11	14.7	8.767	9.152	0.103	-0.385	-0.70
12	14.4	9.069	8.946	0.104	0.123	0.22
13	14.8	9.430	9.232	0.108	0.197	0.36
14	14.8	9.424	9.195	0.105	0.228	0.42
15	13.8	7.557	8.553	0.156	-0.996	-1.85
16	15.1	9.627	9.398	0.127	0.229	0.42
17	14.2	9.022	8.816	0.116	0.206	0.38
18	14.4	8.728	8.950	0.104	-0.222	-0.40
19	13.8	7.677	8.529	0.161	-0.851	-1.59
20	15.3	8.436	9.540	0.150	-1.104	-2.05R
21	14.9	8.502	9.256	0.110	-0.754	-1.37
22	15.6	9.660	9.767	0.192	-0.107	-0.20
23	13.9	9.083	8.582	0.151	0.500	0.93
24	15.2	10.044	9.445	0.134	0.599	1.10
25	14.4	9.428	8.905	0.107	0.523	0.95
26	14.8	9.297	9.230	0.108	0.067	0.12
27	15.5	8.846	9.681	0.175	-0.835	-1.57
28	15.3	9.626	9.543	0.150	0.083	0.15
29	13.8	8.175	8.530	0.160	-0.356	-0.66
30	15.3	9.332	9.513	0.145	-0.180	-0.33
31	15.3	9.711	9.514	0.145	0.197	0.36

Regression of OBOS vs. Total personnel

The regression equation is
OBOS = 9013 + 0.899 Personel

Predictor	Coef	Stdev	t-ratio	p
Constant	9013	1341	6.72	0.000
Personel	0.8989	0.1568	5.73	0.000

s = 5774 R-sq = 53.1% R-sq(adj) = 51.5%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	1096166912	1096166912	32.88	0.000
Error	29	966959040	33343416		
Total	30	2063126016			

Obs.	Personel	OBOS	Fit	Stdev.Fit	Residual	St.Resid
1	3040	15733	11746	1102	3987	0.70
2	404	5489	9376	1302	-3887	-0.69
3	5707	11909	14143	1038	-2234	-0.39
4	1308	6539	10189	1221	-3650	-0.65
5	1116	8654	10016	1237	-1362	-0.24
6	2114	22998	10913	1159	12085	2.14R
7	1373	7237	10247	1216	-3010	-0.53
8	2125	7772	10923	1159	-3151	-0.56
9	355	10544	9332	1306	1212	0.22
10	2356	15123	11131	1143	3992	0.71
11	3650	8013	12294	1074	-4281	-0.75
12	1395	4495	10267	1214	-5772	-1.02
13	9359	24133	17426	1207	6707	1.19
14	7656	19482	15895	1095	3587	0.63
15	3545	4927	12200	1078	-7273	-1.28
16	18843	24007	25951	2346	-1944	-0.37
17	2564	9949	11318	1130	-1369	-0.24
18	2710	12447	11449	1121	998	0.18
19	624	4193	9574	1281	-5381	-0.96
20	1792	7965	10624	1183	-2659	-0.47
21	18107	12444	25289	2243	-12845	-2.41R
22	31403	35810	37241	4203	-1431	-0.36 X
23	510	4981	9472	1292	-4491	-0.80
24	1915	7571	10735	1174	-3164	-0.56
25	3838	20794	12463	1066	8331	1.47
26	9276	20945	17351	1200	3594	0.64
27	5247	22816	13730	1037	9086	1.60
28	7620	24354	15863	1093	8491	1.50
29	538	4076	9497	1289	-5421	-0.96
30	8136	21141	16327	1121	4814	0.85
31	9416	23920	17477	1212	6443	1.14

Regression of ln OBOS vs. ln Total personnel

The regression equation is
ln OBOS = 5.95 + 0.427 ln Pers

Predictor	Coef	Stdev	t-ratio	p
Constant	5.9453	0.5165	11.51	0.000
ln Pers	0.42673	0.06403	6.66	0.000

s = 0.4069 R-sq = 60.5% R-sq(adj) = 59.1%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	7.3533	7.3533	44.42	0.000
Error	29	4.8008	0.1655		
Total	30	12.1541			

Obs.	ln Pers	ln OBOS	Fit	Stdev.Fit	Residual	St.Resid
1	8.0	9.6635	9.3675	0.0731	0.2960	0.74
2	6.0	8.6105	8.5063	0.1466	0.1042	0.27
3	8.6	9.3850	9.6363	0.0845	-0.2512	0.63
4	7.2	8.7855	9.0076	0.0896	-0.2221	-0.56
5	7.0	9.0658	8.9399	0.0958	0.1259	0.32
6	7.7	10.0432	9.2125	0.0761	0.8307	2.08R
7	7.2	8.8870	9.0283	0.0878	-0.1413	-0.36
8	7.7	8.9583	9.2147	0.0760	-0.2564	-0.64
9	5.9	9.2633	8.4511	0.1538	0.8122	2.16R
10	7.8	9.6240	9.2587	0.0744	0.3653	0.91
11	8.2	8.9888	9.4455	0.0744	-0.4567	-1.14
12	7.2	8.4107	9.0351	0.0873	-0.6244	-1.57
13	9.1	10.0913	9.8473	0.1041	0.2440	0.62
14	8.9	9.8772	9.7616	0.0954	0.1156	0.29
15	8.2	8.5025	9.4331	0.0741	-0.9306	-2.33R
16	9.8	10.0861	10.1460	0.1396	-0.0599	-0.16
17	7.8	9.2052	9.2948	0.0736	-0.0896	-0.22
18	7.9	9.4292	9.3185	0.0733	0.1108	0.28
19	6.4	8.3412	8.6918	0.1232	-0.3506	-0.90
20	7.5	8.9828	9.1420	0.0796	-0.1591	-0.40
21	9.8	9.4290	10.1290	0.1375	-0.7000	-1.83
22	10.4	10.4860	10.3639	0.1684	0.1221	0.33
23	6.2	8.5134	8.6057	0.1338	-0.0923	-0.24
24	7.6	8.9321	9.1703	0.0781	-0.2382	-0.60
25	8.3	9.9424	9.4670	0.0750	0.4755	1.19
26	9.1	9.9497	9.8435	0.1037	0.1061	0.27
27	8.6	10.0352	9.6004	0.0820	0.4348	1.09
28	8.9	10.1005	9.7596	0.0952	0.3408	0.86
29	6.3	8.3129	8.6285	0.1310	-0.3156	-0.82
30	9.0	9.9590	9.7876	0.0979	0.1714	0.43
31	9.2	10.0825	9.8499	0.1044	0.2325	0.59

E. NAVAL STATIONS

Table XII NON-PAYROLL OVERHEAD FOR NAVAL STATIONS

Installa -tion	Total SF	MRP (non-payroll)	Personnel	OBOS (non-payroll)
San Diego	3084514	17984	35935	24776
Puget Sound	1316031	7144	2067	4343
Roos. Roads	2867223	15580	2397	27185
Mayport	1673511	3715	11700	18270
Charles-ton	1618269	7919	18068	17287
New York	1294967	1751	2032	13932
Guam	1055908	10515	4080	11646
Norfolk	2855073	18157	57128	44400
Pearl Harbor	3228488	16839	12832	12182

Regression of MRP vs. Square Footage of Facilities

The regression equation is
MRP = - 1917 + 0.00615 Total SF

Predictor	Coef	Stdev	t-ratio	p
Constant	-1917	3177	-0.60	0.565
Total SF	0.006152	0.001402	4.39	0.003

s = 3481 R-sq = 73.4% R-sq(adj) = 69.5%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	233436176	233436176	19.27	0.003
Error	7	84804272	12114896		
Total	8	318240448			

Obs.	Total SF	MRP	Fit	Stdev.Fit	Residual	St.Resid
1	3084514	17984	17060	1792	924	0.31
2	1316031	7144	6180	1608	964	0.31
3	2867223	15580	15723	1572	-143	-0.05
4	1673511	3715	8379	1312	-4664	-1.45
5	1618269	7919	8039	1350	-120	-0.04
6	1294967	1751	6050	1629	-4299	-1.40
7	1055908	10515	4579	1879	5936	2.03R
8	2855073	18157	15648	1561	2509	0.81
9	3228488	16839	17946	1950	-1107	-0.38

Regression of ln MRP vs. ln Square Footage

The regression equation is
ln MRP = - 9.42 + 1.28 ln SF

Predictor	Coef	Stdev	t-ratio	p
Constant	-9.423	7.369	-1.28	0.242
ln SF	1.2783	0.5087	2.51	0.040

s = 0.6261 R-sq = 47.4% R-sq(adj) = 39.9%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	2.4756	2.4756	6.32	0.040
Error	7	2.7439	0.3920		
Total	8	5.2195			

Obs.	ln SF	ln MRP	Fit	Stdev.Fit	Residual	St.Resid
1	14.9	9.797	9.678	0.314	0.120	0.22
2	14.1	8.874	8.589	0.288	0.285	0.51
3	14.9	9.654	9.584	0.287	0.070	0.13
4	14.3	8.220	8.896	0.222	-0.676	-1.15
5	14.3	8.977	8.853	0.229	0.124	0.21
6	14.1	7.468	8.568	0.294	-1.100	-1.99
7	13.9	9.261	8.307	0.374	0.953	1.90
8	14.9	9.807	9.579	0.286	0.228	0.41
9	15.0	9.731	9.736	0.332	-0.004	-0.01

Regression of OBOS vs. Total Personnel

The regression equation is
OBOS = 11138 + 0.505 Personel

Predictor	Coef	Stdev	t-ratio	p
Constant	11138	3271	3.41	0.011
Personel	0.5045	0.1359	3.71	0.008

s = 7239   R-sq = 66.3%   R-sq(adj) = 61.5%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	722241856	722241856	13.78	0.008
Error	7	366806496	52400928		
Total	8	1089048320			

Obs.	Personel	OBOS	Fit	Stdev.Fit	Residual	St.Resid
1	35935	24776	29268	3603	-4492	-0.72
2	2067	4343	12181	3088	-7838	-1.20
3	2397	27185	12347	3060	14838	2.26R
4	11700	18270	17041	2491	1229	0.18
5	18068	17287	20253	2426	-2966	-0.43
6	2032	13932	12163	3091	1769	0.27
7	4080	11646	13196	2925	-1550	-0.23
8	57128	44400	39960	6057	4440	1.12 X
9	12832	12182	17612	2457	-5430	-0.80

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

Regression of ln OBOS vs. ln Total Personnel

The regression equation is
ln OBOS = 6.74 + 0.327 ln Pers

Predictor	Coef	Stdev	t-ratio	p
Constant	6.739	1.389	4.85	0.000
ln Pers	0.3272	0.1522	2.15	0.069

s = 0.5432 R-sq = 39.8% R-sq(adj) = 31.2%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	1.3637	1.3637	4.62	0.069
Error	7	2.0656	0.2951		
Total	8	3.4293			

Obs.	ln Pers	ln OBOS	Fit	Stdev.Fit	Residual	St.Resid
1	10.5	10.118	10.171	0.285	-0.053	-0.12
2	7.6	8.376	9.237	0.281	-0.860	-1.85
3	7.8	10.210	9.285	0.264	0.925	1.95
4	9.4	9.813	9.804	0.188	0.009	0.02
5	9.8	9.758	9.946	0.214	-0.188	-0.38
6	7.6	9.542	9.231	0.283	0.311	0.67
7	8.3	9.363	9.459	0.213	-0.096	-0.19
8	11.0	10.701	10.323	0.342	0.378	0.90
9	9.5	9.408	9.834	0.192	-0.426	-0.84

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